HEALTH INSURANCE STUDIES: CONTRACT RESEARCH SERIES

Report No. 5

HOSPITAL COSTS IN COLORADO: AN ANALYSIS AND COMPARISON

U.S. Department of Health, Education, and Welfare
Social Security Administration
Office of Research and Statistics
HEW Publication No. (SSA) 77-11722

ABSTRACT

A crucial portion of a Prospective Payment Program is the development of an accurate mechanism for assessing the level of an individual hospital's costs. Spectrum Research, supported by Blue Cross of Colorado under their Contract No. HEW 600-75-0198 with the Social Security Administration was required to develop such a mechanism. That is, the objective was to devise a workable technique for assessing the level of individual hospital costs in Colorado. The project findings are thus designed to be directly useful to the Prospective Payment Program in Colorado and to hospitals in that State. They are also intended to be valuable to Blue Cross of Colorado; the Colorado Hospital Association; the Department of HEW and to others concerned about Colorado Hospital Costs.

HOSPITAL COSTS IN COLORADO:

An Analysis and Comparison

by

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with
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and
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This report was prepared under a contract between the Social Security Administration, HEW and Blue Cross of Colorado and was carried out under subcontract by Spectrum Research. The views and opinions expressed in the report are the contractor's and no endorsement by the Social Security Administration or HEW is intended or should be inferred. The project officer for this contract was William L. Damrosch, a staff member within the Division of Health Insurance Statistics, Office of Research and Statistics.

Under the HEW reorganization announced March 8, 1977 the Division of Health Insurance Studies has been transferred to the Health Care Financing Administration.

Contract Number 600-75-0198

Contents

	Preface	v
1.	Purpose	1
2.	Analytical Framework	5
3.	Determinants of Total Cost in Group I Hospitals	17
4.	Determinants of Departmental Costs in Group I Hospitals	38
5.	Determinants of Total Cost in Group II Hospitals	54
6.	Actual/Expected Cost Comparisons for Group I Hospitals	66
7.	Actual/Peer Group Cost Comparisons for Group I Hospitals	73
8.	Departmental Cost Comparisons for Group I Hospitals	88
9.	Cost Comparisons for Group II Hospitals	114
10.	Application of Cost Comparison Results	127
11.	Principal Findings	140
	References	146

Preface

During the last several years Blue Cross of Colorado (CBC) has been involved in the Pilot Prospective Reimbursement Project, whose conduct was mandated by the Colorado State Legislature. In order to broaden the scope of its work on this project, CBC secured a contract from the Social Security Administration (SSA). This Spectrum Research study, which analyzes and compares hospital costs in Colorado, was one of the main activities supported by CBC under its SSA contract.

This volume is the lead report in the Spectrum study. A companion report, entitled Hospital Costs in Colorado: Technical Report, discusses the project findings and methodology in greater depth and with more analytical rigor. In particular, the hospital cost analyses are described in more detail in the Technical Report than in this report. The substantive framework of the analyses is more formally developed; the construction and characteristics of each analysis variable are described, with particular attention to the case mix and related indices; and the analysis findings are presented in technical detail. Certain elements of the hospital cost comparisons are described more rigorously in the Technical Report, but the difference between the two reports is not as great for the cost comparisons as for the cost analyses.

In short, the Technical Report is designed for those individuals who desire a more in-depth understanding of the project findings and methodology. It can be obtained from Spectrum Research or Blue Cross of Colorado.

Hospitals are not identified by name in the cost comparison chapters of this report (Chapters 6-9). Instead, they are identified by randomly assigned numbers, with each hospital retaining its unique number throughout the report. Correspondingly, hospitals are identified by their numbers in the other report chapters if identification by name would make it possible to link specific hospitals with their cost comparison results. In all other instances hospitals are identified by name in these chapters.

Blue Cross of Colorado has substantially assisted this project throughout its duration. Two CBC staff members have been particularly important to this project, and I wish to express my appreciation for their efforts. One is Jim MacDonald, who is Manager of Reimbursement Systems for CBC; and the other is Scott Meiners, who is now a staff member of the Central-Northeast Colorado Health Systems Agency. Mr. MacDonald has given this project solid support since its inception,

and his efforts at several junctures were particularly instrumental in facilitating the completion of this project. Mr. Meiners played an active part in the initial conceptualization of the study, and his encouragement and constructive criticism have been most helpful.

The Colorado Hospital Association (CHA) was extensively involved in the early phases of this study. The administration of the Project Survey was the responsibility of CHA, with Corry Doty of the CHA staff playing the lead role in the completion of this task. She and others at CHA substantially improved the accuracy of the survey data by carefully reviewing the initial responses, questioning hospitals about inconsistencies, and making corrections as appropriate. Ms. Doty also made other significant contributions to this project, and I want to express my appreciation for her work. In addition to Ms. Doty, Wayne Allen of CHA followed the progress of this project from its beginning, and I wish to thank him for his interest. I also want to express my appreciation to Colorado hospitals for completing the Project Survey and for cooperating with the efforts to confirm the accuracy of specific data elements.

I am especially indebted to my associate authors, Tonie Gatch and Nancy Hoffman, who solidly supported my efforts on this project. Ms. Gatch's work markedly improved the style, organization, and format of this report. She also had the central responsibility for assuring the accuracy and consistency of the project data base. Further, she played a major role in the conduct of the hospital cost comparisons, especially the creation of the peer groups. Ms. Hoffman had primary responsibility for managing the cost analyses. Equally important, she played a central role in the construction of the analysis variables. In this role she worked closely with me in the development of case mix and related indices. While Ms. Gatch and Ms. Hoffman were involved in the entirety of this project, their efforts were especially extensive and helpful in the Group II cost analyses and comparisons.

Other Spectrum staff members played important parts in the completion of this project. The editorial contributions of Melissa Culverwell were substantial. Further, she and Sally Specht performed a series of research assistant tasks essential to the conduct of the study. The actual production of this report was carefully and imaginatively carried out by Ms. Specht, David DeWolf, and Michael Finnerty. This project entailed both substantial and complex data processing work, which Janet Seston completed in admirable fashion. I want to thank each of these Spectrum staff members not only for their specific efforts, but also for maintaining a positive and encouraging attitude during their work.

Former Spectrum staff members also made significant contributions to this project, and I wish to express my appreciation to them. Peter Shaughnessy, who is now associated with the University of Colorado, played a central role in the initial conceptualization of this project, working closely with me and with Scott Meiners in this

effort. He also had important management responsibilities in the early phases of this study. Alice Bryant, now a staff member in the Colorado Governor's office, made significant contributions to the creation of the case mix and related indices, and played a sizeable part in the development and conduct of the Project Survey. In addition, Carol Shaughnessy, Garry Toerber, Steve Lazarus, David Landes, and Jean Bell assisted the development of this project in different ways.

As noted, a number of individuals have made important contributions to this project. Nonetheless, the contents of this report remain my responsibility as well as that of my associate authors. In particular, the views and conclusions of this report should not be attributed to either of its sponsors -- Blue Cross of Colorado or the Social Security Administration.

Patrick O'Donoghue

Denver, Colorado
June 1977

1

Purpose

Hospital costs in this country increased by 281% from 1966 through 1975. In contrast, the Consumer Price Index rose by 66%. Similarly, in the Denver metropolitan area,[1] hospital costs and consumer prices increased by 292% and 63% respectively during that decade.[2] As a result, the cost of hospital care is now a major policy issue both in the United States as a whole and in Colorado.

Federal policymakers are frequently distressed about Medicare expenditures and health care costs generally; and the President recently proposed that a limitation of 9% per year be placed on hospital cost increases. State Medicaid program expenditures are continually overwhelming previous budgetary estimates, and hospital costs are a frequent subject of debate in state legislatures. Private industry finds that the costs of its health care fringe benefits are continually accelerating, so that it has now become almost a colloquial saying that there is "more health care than steel in new automobiles." Like other policy issues, the general concern about hospital costs is mirrored in the public press, with such action words as "skyrocketing" and "bloated" attached to such costs.

For many years hospitals were paid on the basis of charges for different services. Such charges often bore little relationship to the actual costs of providing the particular services, and were almost never actively reviewed by third-party payors. With the advent of the Medicare program in 1966, there was a rapid shift toward reimbursing hospitals retrospectively on the basis of their actual costs during the preceding reporting period. While this retrospective approach has the advantage of being more precise,

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[1] The Denver metropolitan area is used here, rather than Colorado, since an index of consumer prices is not compiled for the state.

[2] This comparison is not entirely equitable to the hospital sector, since a major component in the increased cost of hospital care is the continuing evolution of the product toward more complex care -- a factor largely unreflected in the Consumer Price Index. While change in the nature of the product characterizes many industries, the pace of such change has generally been more rapid in the hospital area. Nonetheless, this comparison points up the marked difference in the relative magnitude of hospital cost increases and general price inflation.

it offers hospitals no incentives to reduce their costs. In fact, the incentives run in the reverse direction. As long as a cost can be "justified" after the fact by the hospital, it will be covered by the third-party payor.

As a consequence, prospective payment programs have become increasingly attractive during the last decade. Under such programs hospitals are paid on the basis of rates established in advance. The incentives are the opposite of those in a retrospective reimbursement system. Once prospective rates are established, the hospital has an incentive to reduce its costs since it can retain the difference (or at least a proportion thereof) between its actual cost(s) and the prospective rate(s). Equally important, the adoption of a prospective payment approach often produces a change in emphasis from intricate cost details to factors more broadly influencing cost.

One of the earliest prospective payment programs was initiated in 1960 by Indiana Blue Cross with the assistance of the Indiana Hospital Association. Since then, this program has remained a private system, with little federal or state government involvement. A somewhat similar system was established even earlier, but for a smaller number of hospitals, by Blue Cross of Southwest Ohio. In 1970 a state-operated hospital cost control program was instituted in New York. More recently, hospital cost commissions premised on the prospective payment approach have been established in such diverse states as Washington, Massachusetts, and Maryland. During the 1970s, other prospective payment programs were instituted in such areas as Rhode Island, New Jersey, and Western Pennsylvania.[3] The federal government especially the Social Security Administration (SSA), has been involved in the prospective payment area since the late 1960s, but the depth of its interest has become much greater during the last five years.

Developments in Colorado have reflected those outside the state. In 1973 a state law was passed directing Blue Cross of Colorado (CBC) to institute a Pilot Prospective Reimbursement Project, which has now been completed.[4] The recent rulings of the State Insurance Commissioner have emphasized the importance of prospective payment principles. During the last several years CBC and the Colorado Hospital Association (CHA) have furthered the evolution of prospective payment approaches in the state, both through their general efforts and their specific involvement in the Pilot Project.

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[3] Bauer et al (1974) describe the characteristics of a number of prospective payment programs in different parts of the country. O'Donoghue (1974) summarizes early studies of prospective payment programs.

[4] As indicated in the Preface, CBC obtained a contract from SSA to intensify its efforts on the Pilot Prospective Reimbursement Project. This Spectrum Research study is one of the efforts supported by CBC under this SSA contract.

The culmination of these developments came in 1977 with the enactment of a law establishing a state hospital commission. The explicit charge of the newly created Colorado Hospital Commission is "to restrain the rising costs of hospital care." The Commission is to achieve this objective through "a system of prospective budget review and approval of budgets, costs, and charges." All hospitals licensed in the state are subject to the Commission. The Commission is to become an operating program on October 1, 1977, and all hospital budgets and rates must be approved by the Commission for all fiscal years beginning after March 1978.

In any prospective payment program, a crucial question is: How will the costs of individual hospitals be evaluated? On what basis will a determination be made that a hospital's costs are too high, about right, or relatively low? This question is central to the effectiveness of a prospective payment program. If the program does not have an accurate mechanism for assessing the level of an individual hospital's costs, it cannot logically decide how to respond to a hospital's rate request.

The purpose of this project is to develop such a mechanism. That is, its objective is to devise a workable technique for assessing the level of individual hospital costs in Colorado. The project findings are thus designed to be directly useful to a prospective payment program in Colorado[5] and to hospitals in this state. They are also intended to be valuable to Blue Cross of Colorado; the Colorado Hospital Association; the Social Security Administration; and to others concerned about Colorado hospital costs, including planning agencies, the state Medicaid program, other state government units, state legislators, local government units, private insurors, physicians, private industry, labor unions, and the consuming public.

The most elemental principle underlying this project's findings is that any approach to hospital cost assessment must begin by considering the major factors influencing hospital cost. If this is not done, the assessment of hospital costs will start too far downstream, and will become embroiled in small points before attaining a broad perspective. Given the complexity of the hospital sector, a prospective payment program assessing costs in this manner is likely to become adrift in a sea of details, unable to find a solid starting point from which to begin its deliberations.

Illustrating these principles, hospital cost assessment should not begin with a consideration of such detailed points as the impact of a unique but small service offered by one hospital or the implications of a particular grade of carpeting used by another hospital.

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[5] When this project was conceived, it was thought possible (although not necessarily likely) that CBC, in cooperation with CHA, might establish a prospective payment program. Instead, as indicated earlier, the new Colorado Hospital Commission will be the prospective payment program in this state.

Further, it should not commence by evaluating factors with broader implications, but which are confined to only one or two hospitals, such as a large expansion or contraction of the major industry in a particular area. Instead, hospital cost assessment should begin by examining those factors which primarily determine hospital costs. Through this approach each hospital's actual costs can be compared to the expected level of its costs given its values for the major cost-influencing factors. That is, each hospital's actual costs can be evaluated in terms of a comparison standard based on the factors broadly determining costs.

Therefore, the first step in hospital cost assessment should be to identify the primary cost-influencing factors, i.e., the major cost determinants. The second step should be to compare the actual cost of each hospital to its expected cost based on its values for the cost determinants. This project uses this two-step approach to accomplish its objective of developing a usable mechanism for assessing hospital costs. Accordingly, these two steps -- the cost analyses and the cost comparisons -- are the main subject of this report.

While assessment of Colorado hospital costs is its main purpose, this project also has an important secondary objective -- to demonstrate the validity and usefulness of its methodology.[6] This latter objective is important since an effective and equitable method for evaluating hospital costs is required in many settings in this country at the present time. From this perspective Colorado is a suitable subject for this project. It is sufficiently similar to other states that if this study's methodology can be employed successfully in Colorado, it is likely that it can be used effectively in most other settings.

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[6] As indicated in this report, a number of studies have analyzed hospital costs. However, most such studies have not attempted to use the cost analysis results to construct comparison standards for assessing individual hospital costs. The two earlier studies which most closely resemble this project are Shuman, Wolfe, and Hardwick (1972); and Lave, Lave, and Silverman (1973). The findings of these studies have been especially valuable to this project.

2

Analytical Framework

The purpose of this chapter is to present an overview of this project's analytical framework.[1] The first topic addressed is the rationale for the division of Colorado hospitals into two groups for the purpose of this project, and the identification of the hospitals in those groups. The chapter then describes the types of analyses employed; the specification of the hospital sample; and the selection of the cost variables. It closes with a discussion of the nature of cost-influencing factors, emphasizing the crucial distinction between exogenous and endogenous variables.

Creation of Two Hospital Groups

This project is directed toward acute hospital care provided in nonfederal institutions. Consistent with this focus, all 79 nonfederal, short-term, general and related hospitals in Colorado are included in this study. Unlike hospitals in certain other states, a substantial fraction of Colorado hospitals are very small.[2] This fact would cause little concern if it were likely that similar factors influence cost in different sized hospitals. While this seems a valid assumption across most of the hospital size spectrum, it appears questionable for very small hospitals. For example, a hospital with an average daily census of ten patients is almost certain to provide sharply different services than a hospital with an average daily census of 50 or 250.

In regression analysis, which is the methodology used to conduct the cost analyses, each hospital is given equal weight. A large hospital responsible for 5% of total state hospital costs would thus be accorded the same importance as a very small hospital accounting for less than .1% of state hospital costs. That is, the analysis attempts to fit the cost equation as closely to the very small hospital as to the large hospital.

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[1] The project methodology is discussed in greater depth in the Technical Report, which is described in the Preface.

[2] For example, only two of the 110 acute care hospitals in Indiana have an average daily census less than 20.

Hence, if there are important differences between the factors influencing the costs of large and very small hospitals, analysis of costs across the entire set of Colorado hospitals runs the serious risk of not predicting the costs of either type of hospital as accurately as would separate analyses. From the perspective of restraining total hospital costs in Colorado, this potential inaccuracy is more serious for the large hospitals, which are responsible for the great majority of hospital costs. However, for both large and very small hospitals the single group approach might yield results inequitable to individual institutions and/or suggestive of inappropriate policy initiatives.

Consequently, the Colorado hospital universe was divided into two groups for this study -- one consisting of very small hospitals and the other composed of the remaining hospitals in the state. Bed size could have been used to create these groups, but it suffers from a serious deficiency. It indicates the degree to which hospital services are potentially available, but not the extent to which they are provided. In contrast, average daily census encompasses both the number of beds in the hospital and their occupancy rate, thus representing the size of the hospital as an operating entity -- the crucial issue from the standpoint of this study.

As implied above, the intent in establishing two hospital groups was not to create two groups of equal size, but rather to separate very small hospitals from other Colorado hospitals. After discussions with CHA and CBC, it was determined that in Colorado the most appropriate dividing line for this purpose was an average daily census of 20 patients. Group I thus consists of those hospitals with an average daily census greater than 20; and Group II is composed of those hospitals with an average daily census less than 20. As indicated in Tables 2-1 and 2-2 respectively, there are 50 Group I hospitals and 29 Group II institutions.

Table 2-1

GROUP I HOSPITALS

Hospital	Location	Average Daily Census
St. Anthony	Denver	462.5
St. Joseph	Denver	458.1
St. Mary Corwin	Pueblo	376.2
Penrose	Colorado Springs	340.6
Presbyterian	Denver	330.6
St. Luke's	Denver	328.1
U. of C. Medical Center	Denver	321.6
General Rose	Denver	276.2
Lutheran Medical Center	Wheat Ridge	268.7
Mercy	Denver	268.1
Weld County	Greeley	244.1
Denver General	Denver	230.5
Swedish	Englewood	223.8
Porter Memorial	Denver	215.6
Parkview Episcopal	Pueblo	213.2
Valley View	Thornton	173.3
St. Mary's	Grand Junction	154.3
Beth Israel	Denver	140.8
Poudre Valley	Fort Collins	130.6
Boulder Community	Boulder	117.5
St. Francis	Colorado Springs	115.8
Memorial	Colorado Springs	115.2
Children's	Denver	112.2
Rocky Mountain Hospital	Denver	105.4
Eisenhower Osteopathic	Colorado Springs	83.7
Longmont United	Longmont	81.3
Mercy	Durango	81.1
Logan County	Sterling	62.2
Boulder Memorial	Boulder	61.9
St. Thomas More	Canon City	53.8
Montrose Memorial	Montrose	49.7
La Junta Medical Center	La Junta	46.1
Mount San Rafael	Trinidad	44.3
Alamosa Community	Alamosa	43.5
Loveland Memorial	Loveland	40.7
Southwest Memorial	Cortez	40.1
Salida	Salida	39.6
Grand Junction Osteopathic	Grand Junction	38.8
La Plata Community	Durango	33.2
Conejos County	La Jara	29.0
Brighton Community	Brighton	28.5
Kit Carson County	Burlington	27.8
Huerfano Memorial	Walsenburg	26.8
Prowers Medical Center	Lamar	25.8
Valley View	Glenwood Springs	25.5
Mesa Memorial	Grand Junction	25.2
Aspen Valley	Aspen	24.3
Fort Morgan	Fort Morgan	23.4
St. Joseph	Florence	22.7
St. Vincent General	Leadville	21.2

Table 2-2

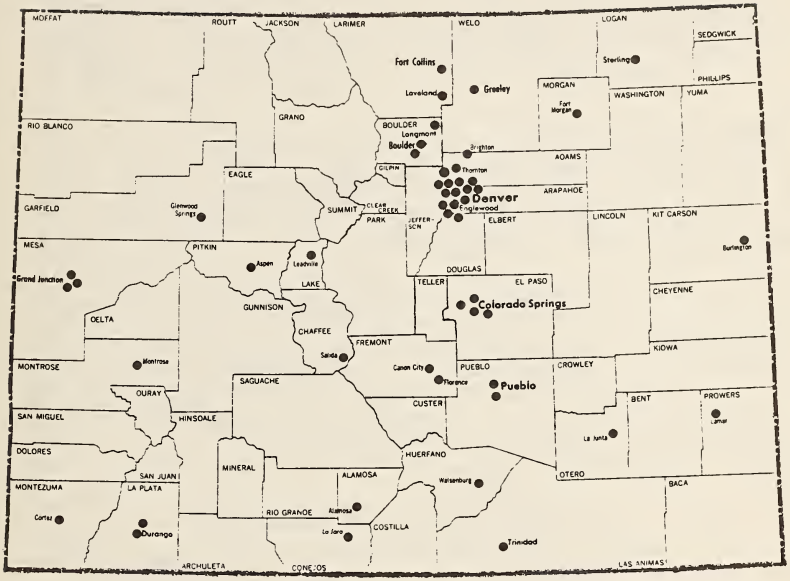
GROUP II HOSPITALS

Hospital	Location	Average Daily Census
St. Joseph	Del Norte	19.7
Memorial	Greeley	19.3
Delta County	Delta	18.1
Monte Vista Community	Monte Vista	18.1
Memorial	Craig	17.0
Pioneers Memorial	Rocky Ford	16.9
St. Joseph of the Plains	Cheyenne Wells	16.3
Wray Community	Wray	12.7
Clagett Memorial	Rifle	12.6
Southeast Colorado	Springfield	12.0
Sedgwick County	Julesburg	11.6
Routt County Memorial	Steamboat Springs	11.5
East Morgan County	Brush	10.9
Middle Park	Kremmling	10.6
Haxtun Hospital District	Haxtun	10.6
Walsh District	Walsh	9.8
Lincoln Community	Hugo	9.8
Gunnison	Gunnison	9.3
Yuma District	Yuma	8.7
Melissa Memorial	Holyoke	7.7
Bent County Memorial	Las Animas	6.9
Lower Valley	Fruita	5.7
Rangely District	Rangely	5.5
Pioneers of Rio Blanco	Meeker	4.8
Washington County	Akron	4.5
Vail Valley Medical Center	Vail	4.2
Weisbrod Memorial	Eads	3.1
Plateau Valley	Collbran	2.8
McNamara Mercy	Fairplay	1.4

Group I hospitals account for 97% of hospital costs in Colorado. Hence, even if a prospective payment program were successful in reducing Group II hospital costs by 20%, the net effect would be a decrease in state hospital costs of only .6%. The same point applies to future rates of cost inflation. To be effective as a cost regulator, a prospective payment program must therefore devote greater attention to Group I hospitals. By pointing up differences in the cost determinants for the two types of hospitals, and by producing more accurate findings for both types, the two-group approach facilitates differential emphasis on Group I hospitals.

Figure 2-1

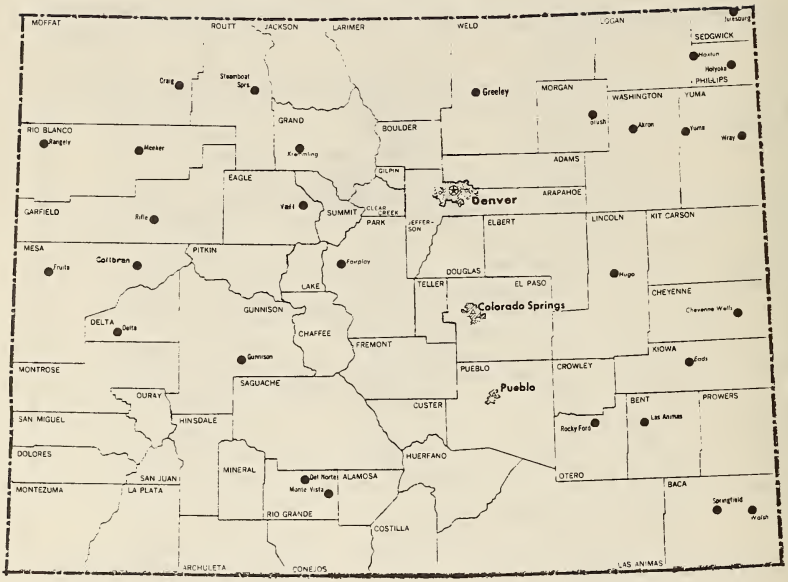
LOCATION OF GROUP I HOSPITALS



As indicated in Figure 2-1, Group I institutions are concentrated in the metropolitan areas of Colorado. Nineteen hospitals, or almost 40% of this group, are in the Denver metropolitan area; nine institutions, or almost 20% of the group, are in the smaller metropolitan areas of Colorado Springs, Pueblo, Fort Collins, and Greeley. The remaining 22 hospitals, or more than 40% of this group, are thus located outside metropolitan areas. Thirteen of these 22 institutions are located west of the Front Range, with the remaining nine hospitals situated east of that range.

Figure 2-2

LOCATION OF GROUP II HOSPITALS



In contrast to Group I, only one Group II institution is in a metropolitan area (Memorial Hospital in Greeley), as shown in Figure 2-2. The remaining 28 hospitals are evenly divided between locations west or east of the Front Range. They tend to be concentrated in three corners of the state (northeast, southeast, and northwest).[3]

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[3] Some observers have proposed that Colorado hospitals be segregated in terms of socioeconomic characteristics, especially the hospitals' location or nonlocation in metropolitan areas. As indicated above, such an approach would yield results somewhat similar to that produced by using an average daily census of 20 as the dividing line, but there would be substantial differences. More important, the use of metropolitan location or another socioeconomic dimension as a single characteristic to divide Colorado hospitals is inappropriate. The issue in this state is not wide disparity among hospitals in terms of socioeconomic characteristics, but rather in terms of size.

Types of Analyses

As noted earlier, regression analysis is the main analytical technique employed in this study. Correlation analyses, which complement regression techniques, were also an integral part of the quantitative methodology, with profile analyses being used for supplementary purposes. Since the objective of this project is to develop tools for comparing the costs of individual hospitals, the hospital is always the unit of analysis.

The time period employed in this project is the financial reporting period from 1 July 1974 through 30 June 1975 (the June 1975 fiscal year). This time period began three months after the termination of the Economic Stabilization Program (ESP) in April 1974. Hence, it is beyond not only the direct influence of ESP, but also the immediate post-ESP period, when many hospitals made a number of rapid adjustments.

Both total and departmental costs of Group I hospitals are analyzed. The total cost analyses form the basis of the principal cost comparisons for Group I hospitals. The departmental cost analyses are complementary, yielding cost comparisons which provide important insights about the hospital's cost performance. For example, if a hospital's actual costs are substantially higher than its expected costs, is this finding due to higher nursing costs, greater administrative costs, and/or higher levels of other departmental costs?

Departmental cost analyses are not applicable to Group II hospitals, since their complexity is not sufficient to warrant such analyses. Only the total costs of these institutions are analyzed.

Specification of the Sample

This project utilizes three principal data sources. One is the computerized information base maintained by CBC and drawn from data provided on Blue Cross claims forms. Another is the Project Survey, which was jointly prepared by CHA, CBC, and Spectrum Research, and which was administered by CHA. The third source is the data base maintained by the Bureau of Census. Supplementary date sources were employed for specific variables as appropriate.

Two of the principal sources, CBC claims data and Census data, have complete observations for all hospitals. A few hospitals (termed nonrespondents) did not complete the Project Survey, only partially completed the Survey, or furnished data for a time period other than that requested.

These nonrespondents posed a dilemma. On the one hand, it was important to assess the costs of each Colorado hospital, so that a possible prospective payment program would have a fully operational tool. On the other hand, if variables for the nonrespondents were constructed from data sources other than the Project Survey, it was possible that the cost analyses might be less accurate. In other words, there was a chance that if the nonrespondents were included in the cost analyses, the cost estimates for the other Colorado hospitals might be less valid.

To resolve this dilemma, nonrespondents were excluded from the cost analyses, but included in the cost comparisons. This approach is satisfactory for two reasons. First, the number of nonrespondents is small relative to the total group. Second, the nonrespondents' values for the cost determinants fall within the same general range as the respondents' values for these determinants. For example, length of stay is an important cost determinant for Group I. No Group I nonrespondent has a length of stay distinctly different from the lengths of stay of the respondents.

There are three nonrespondents in Group I: Hospitals (03), (09), and (29).[4] The Group I cost analyses thus include 47 hospitals, or 94% of the total group. Group II also has three nonrespondents: Hospitals (63), (68), and (74). The Group II analyses thus contain 26 institutions, or 90% of the total group.

Selection of the Cost Variables

Two hospital cost measures have been commonly employed in other studies -- cost/admission and cost/patient day. The former was selected as the primary dependent variable for this project mainly because the admission is a more discrete output than the patient day. That is, the primary unit consumed or provided is the herniorrhaphy, the delivery of twins, or the admission for a duodenal ulcer, rather than the individual patient day for any of these conditions.

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[4] As described in the Preface, hospitals are not identified by name in this report when such identification would permit linkage of individual hospitals with their cost comparison results. In such instances hospitals are identified by randomly assigned numbers, with each hospital keeping the same number throughout the report. Group I hospitals were assigned numbers from (01) through (50), and Group II institutions were given numbers from (51) through (79).

As discussed later, length of stay is considered a short-run exogenous factor in this project and is thus included in the independent variable set. This being the case, the results of cost/admission and cost/patient day analyses would be expected to be highly similar because length of stay is the characteristic which distinguishes cost/admission from cost/patient day. Preliminary analyses substantiated this expectation. Cost/patient day was consequently not used as a dependent variable in the final analyses. Correspondingly, the departmental cost variables are defined in terms of departmental cost/admission.

Nature of Cost-Influencing Factors

If a factor is a final cost determinant, the subsequent hospital cost comparisons will take into account cost differences produced by variations in that factor. In other words, the cost comparisons, and by extension the prospective payment system, consider such cost differences justifiable. For example, if hospital bed size is a final cost determinant, the implication is that variations in bed size among hospitals legitimately account for cost differences among hospitals.

Factors influencing cost can be divided into two categories -- exogenous variables and endogenous variables. The former are outside the control of the individual hospital, and the latter are within its influence.

In evaluating hospital costs and establishing hospital rates, differences among hospitals in terms of exogenous variables should be taken into account. Hospitals should be neither rewarded nor penalized for cost differences arising from variations in exogenous variables, since by definition a hospital cannot change its exogenous variables, regardless of pressure exerted by a prospective payment program. For example, the income level and other socioeconomic characteristics of the hospital's environs can be influenced only minimally, if at all, by the actions of an individual hospital. A hospital should thus not be penalized simply because it is located in a high income county or metropolitan area and must consequently pay higher wages and incur higher costs.

In contrast, cost differences among hospitals due to variations in endogenous variables should not be routinely recognized by a prospective payment program, since a hospital influences its costs by modifying its endogenous variables. For example, in response to a prospective payment program a hospital might lower its rate of cost inflation by improving labor productivity. Accepting variations

in endogenous variables is tantamount to accepting all cost differences among hospitals. Such an approach would destroy the effectiveness of a prospective payment program.

Thus, endogenous variables should be excluded from the independent variable set of this study, i.e., they should not be eligible to be final cost determinants. Conversely, exogenous variables should be included in the independent variable set.

The distinction between exogenous and endogenous varies with the length of time over which hospital behavior is being influenced. If the time period is short (perhaps a year), many hospital characteristics are exogenous. If the time period is longer (perhaps two or three years), more hospital characteristics become endogenous, and fewer remain exogenous. If the time period is still longer (perhaps ten years), most hospital characteristics are endogenous. As an example, consider hospital service mix. In the short run, service mix is exogenous because it cannot be substantially modified in six months or a year. At the end of three years service mix is partially endogenous, and by the end of a decade, it is almost entirely so.

The hospital cost comparisons undertaken in this study are designed for potential use by a prospective payment program during its early years of operation. Consequently, a limited time perspective is assumed. A factor is considered endogenous only if it is reasonably likely that it could be significantly influenced by a hospital over the course of one year. To emphasize the distinction between exogenous variables which remain exogenous indefinitely and exogenous variables which become endogenous over time, the former will be termed long-run exogenous variables and the latter, short-run exogenous variables.

An important element in determining whether a factor is short-run exogenous or endogenous is the extent to which it is controlled by the hospital administrative staff rather than the physician staff. The former is the primary target of most prospective payment programs. That is, most programs affect hospital costs by influencing the behavior of the administrative staff (and by extension, the board members). In contrast, the practicing physician is usually relatively distant from prospective payment programs. At a minimum it is rare for practicing physicians to share in the financial rewards and risks inherent in a prospective payment program. Hence, it is more appropriate to characterize as exogenous those factors primarily determined by physicians than those influenced mainly by administrators. Correspondingly, physician-influenced factors can be

justifiably retained as exogenous variables for a longer period of time than can administrator-influenced factors.[5]

A prospective payment program may decide to consider a factor exogenous or endogenous for substantive reasons. If a program elects to consider a factor exogenous even though it realizes that this factor is within the hospital's influence, this means the program is willing to accept cost differences caused by this factor. A program may wish, for example, to not discourage hospital involvement in emergency and ambulatory care. If so, the program may elect to consider such involvement "exogenous" and to retain that classification over time, so that a hospital would not be penalized for having higher costs because of such involvement.

Conversely, if the prospective payment program chooses to consider a factor endogenous even though it is unlikely that it will be influenced by the program, this indicates the program is not willing to recognize cost differences occasioned by the factor. One instance of this type arose in this study. It is unlikely that a hospital will make a major change in its control type (e.g., from nonprofit to local government or for-profit) in response to a prospective payment program. Nonetheless, CBC was unwilling to routinely accept cost differences among hospitals due to variations in control type -- a decision with which Spectrum Research and CHA concurred.

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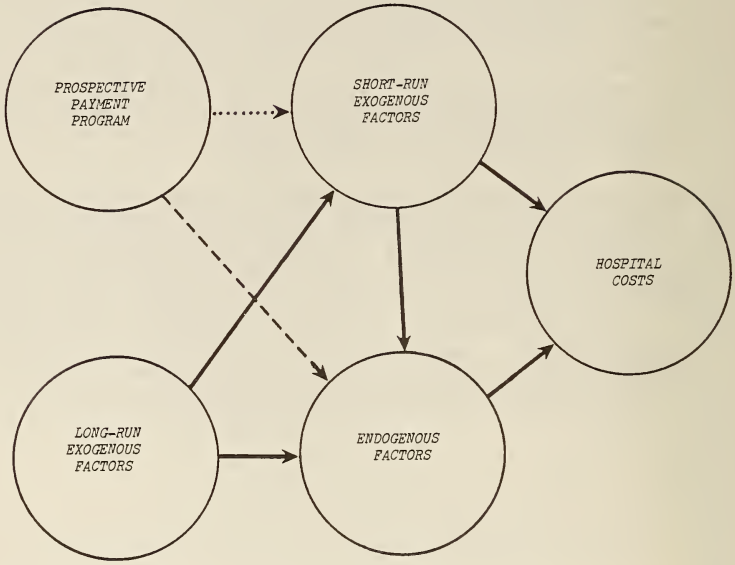
[5] If a prospective payment program were closely tied to a utilization review and/or quality assurance program, the distinction between physician-influenced and administrator-influenced factors would have less clear implications. However, the linkages between existing prospective payment programs and utilization review programs have been weak.

Figure 2-3

RELATIONSHIPS AMONG COST-INFLUENCING FACTORS



These discussions are summarized in Figure 2-3, which shows the relationships among the different types of variables. A solid arrow indicates the influence of one type of factor on another and the direction of that influence. The dashed arrow indicates the immediate potential influence of a prospective payment program on endogenous variables. The dotted arrow between the program and the short-run exogenous variables shows that the former may eventually affect the latter. The lack of an arrow between the program and the long-run exogenous variables emphasizes the absence of a relationship between these two entities.

3

Determinants of Total Cost in Group I Hospitals

The subject of this chapter is the total cost analyses for Group I hospitals. The major product of these analyses is the final total cost equation, which forms the basis for the Group I total cost comparisons. This equation has six independent variables, each of which is thus a determinant of total cost in Group I hospitals. The first section of this chapter is directed toward these determinants. It describes their effects on cost and discusses the probable rationale for those effects. The second section addresses the final cost equation as a whole, discussing its properties and its consequent suitability to serve as the underlying tool in the cost comparisons.

The cost analyses were conducted in a series of logical steps.[1] Hence, in addition to the final cost equation, there are a number of intermediate cost equations. Three factors have a significant influence on cost in some of these intermediate equations, but their effects are reduced to insignificance in later equations by the inclusion of one or more of the final cost determinants. This chapter's third section discusses those three factors. A number of other factors were also included in the analyses, but had an insignificant impact on cost throughout. The fourth section of this chapter considers these factors.

As emphasized in Chapter 2, endogenous variables should not be (and are not) included in the cost analyses. The fifth chapter section briefly points out some of the factors that are considered endogenous in this project. The final section concisely summarizes the chapter.

This project, especially the Group I cost analyses, draws upon the knowledge base established by earlier studies of hospital cost. Prominent among such studies are M. Feldstein (1967, 1970, and 1971); Lave et al (1970, 1972, 1973, and 1976); Shuman, Wolfe, et al (1972 and 1976); Davis (1973 and 1974); Salkever et al (1972 and 1976); Pauly et al (1970 and 1975); Dowling et al (1974 and 1976); Rafferty et al (1972 and 1976); Cohen (1970); Evans et al (1971 and 1972); Carr and P. Feldstein (1967); and Berry (1967, 1974, and 1976). Two Spectrum Research studies -- the Metropolitan

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[1] Each of these steps is described in the Technical Report.

Area Study (1977) and particularly the Indiana Study (1977)[2] -- were also important sources for the conduct of this project.

Final Cost Determinants

Medical Education Involvement

Medical education programs attract a complex case mix because they frequently employ highly trained specialists as instructors, and because they deliberately seek a wide range of cases in order to broaden the experience of residents, interns, and medical students. Not only is case mix more complex in hospitals with medical education programs, but at times the intensity of services is higher for the same types of cases (e.g., cholecystectomy patients may receive more ancillary tests in these hospitals than in hospitals without medical education programs). As a result of these case mix and service intensity effects, medical education involvement (defined as the ratio of the hospital's full-time equivalent interns and residents to its bed size) has a strong positive influence on cost.

Participation in medical education programs is primarily controlled by the hospital physician staff (and in many instances by the faculty members of the medical school(s) with which the hospital is affiliated). Except in rare situations, those physicians playing a lead role in medical education programs consider such work an essential component of their professional lives. They would be highly reluctant to modify their medical education programs in response to pressure from a prospective payment program. Similarly, hospital administrators and board members will be disinclined to alter their medical education programs, since the nature of such programs is important in determining a hospital's prestige and its resulting ability to attract physicians.

It is thus highly unlikely that implementation of a prospective payment program would appreciably change hospital participation in medical education. It is therefore appropriate to consider medical education involvement a long-run exogenous factor.

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[2] The Indiana Study is a Spectrum Research project supported by the Social Security Administration. Its purpose is to determine the effects of the Indiana Prospective Payment Program. That is, it is directed toward such questions as: What is the impact of the Indiana Program on hospital costs? Through which factors -- productivity, wage levels, quality, etc. -- does the Indiana Program affect costs?

The Metropolitan Area Study, sponsored by the National Science Foundation, analyzes the factors influencing the distribution and utilization of hospital and other health care resources in metropolitan areas.

Income Level

The income level of the community (per capita income of the metropolitan area or county)[3] in which a hospital is located is indicative of the prevailing economic conditions of the community, and thus of its general wage levels. This factor consequently has a strong impact on hospital wage rates. Further, it is partially reflective of the prices of other goods and services used by hospitals (e.g., construction and land costs). However, the prices of some hospital inputs are largely independent of community income levels, e.g., drugs and specialized equipment.

Income level may impact the demand for hospital care through two mechanisms. First, communities with a higher socioeconomic status may exhibit hospital care consumption patterns different from those in communities with a lower socioeconomic status. Second, income level reflects the ability of consumers to pay for hospital care, although this element is now less important because of the pervasiveness of hospital insurance coverage.

While these demand effects of income level may be appreciable, they are generally weaker than the strong supply effects of this factor. It is the latter which primarily account for the strong positive impact of this factor on cost. That is, income level influences cost mainly because it increases the prices that hospitals must pay for inputs, especially labor resources.

Although the hospital industry is a significant employer in many areas, it would still be exceedingly unusual for a prospective payment program to influence the income level of the community. This factor must thus be considered a long-run exogenous variable.

Long-Term Care Involvement

The principal objective of Group I hospitals is to provide acute inpatient care. In addition to the services provided incident to this purpose, these hospitals offer services less directly related to inpatient care. The scope of most such services is small, and thus they have only minor cost implications.[4] An important

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[3] For metropolitan hospitals, the metropolitan area was chosen as the geographic unit most closely approximating the community of hospital location; and for nonmetropolitan hospitals, the county was chosen as the geographic unit most representative of the community of hospital location.

[4] Non-patient care costs, such as those for a gift shop, parking lot, or physicians' office building, are not included in total hospital costs in this project. It is therefore unnecessary to incorporate factors depicting such hospital activities in the cost analyses.

exception is the extent of hospital involvement in long-term care, which includes intermediate care, rehabilitation, and other chronic care, as well as skilled nursing care. As expected, this factor (defined as the ratio of the hospital's long-term care patient days to its acute inpatient days) is dominated by the latter type of care.

An array of detailed statistics would be required to accurately separate the costs of long-term care (including hotel, administrative, capital, and ancillary costs[5] occasioned by such care) from the costs of acute inpatient care. Since most hospitals did not collect such statistics during the study period, it was not possible to isolate long-term care costs. Hence, these costs are included in total hospital costs, i.e., the numerator of the cost/admission variable. Conversely, long-term care utilization is excluded from the denominator of cost/admission.[6] Thus, if long-term care costs are sufficiently high, this factor can have a positive effect on cost.

Although only six Group I hospitals provide long-term care, the extent of their involvement is often large. In fact, long-term care patient days equal more than 50% of acute inpatient days in three of these institutions. As a result, long-term care involvement has a strong positive impact on cost.

The principal mission of hospital prospective payment programs is to restrain the costs of acute inpatient care. Most such programs have remained relatively neutral regarding involvement in long-term care. Independent of the merits of hospital involvement in such care, it would seem inadvisable for a new prospective payment program to attempt to alter hospital involvement in long-term care before it had demonstrated its ability to lower the inflation of acute inpatient costs. Long-term care involvement should therefore not be considered an endogenous variable.

It is also inappropriate to consider this factor a long-run exogenous variable, since it could be substantially affected by a prospective payment program at some point in time. Hence, long-term care involvement must be classified as a short-run exogenous factor.

Except for medical education involvement, this latter argument also applies to the other hospital characteristics included in the Group I

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[5] These variables as well as nursing cost are the five departmental costs used in this project. Their general nature is indicated by their names, and they are fully described in the next chapter.

[6] This approach was adopted because equivalence in terms of cost implications has not yet been established for acute inpatient care and long-term care.

analyses, such as length of stay, case mix, and bed size. These factors can be influenced eventually by a prospective payment program, and thus should not be considered long-run exogenous variables.

Length of Stay

For two reasons, this factor has a strong positive influence on cost. First, the longer the length of stay for any reason, the higher will be hospital cost, since expenses per day remain positive throughout the hospital stay although they decline during the convalescent stage of illness. Second, length of stay is often long because of greater case severity and more complex case mix. To the extent that this is true, cost will be higher because more ancillary, nursing, and other services will be required to treat the patient.

Length of stay is strongly influenced by case mix, case severity, utilization practices, and elderly caseload. As discussed later in this chapter, each of these factors is predominantly determined by the physician staff. By extension, the same is true for length of stay, which should thus be considered a short-run exogenous variable.

Surgical Concentration

The ancillary service intensity of all surgical cases is high. Patients undergoing an operation utilize such direct surgical services as operating room, anesthesia, and recovery room. They are substantial consumers, both pre- and post-operatively, of diagnostic services such as laboratory, x-ray, and EKG. Intravenous and blood therapy are extensively provided to surgical patients. The same is true, but to a lesser extent, for respiratory and physical therapy.

Similarly, nursing intensity of surgical care is high. In the immediate post-operative period, surgical patients often require extensive general nursing care. In addition, specialized nursing care, such as wound irrigation and dressing changes, is at times required during the post-operative stage.

In contrast, surgical concentration (defined as the ratio of inpatient surgical cases to admissions) has little influence on length of stay. Some surgical cases require very short stays, such as tonsillectomy and adenoidectomy, breast biopsy, and dilation and curettage of the uterus. Others require long lengths of stay, e.g., operative treatment of gastrointestinal cancer, gallbladder removal, and repair of an intervertebral disc. The net effect of these differing lengths of stay for surgical cohorts is an insignificant relationship between average length of stay and surgical concentration.

Because of its impact on service intensity, surgical concentration has a substantial positive effect on cost. As with length of stay, this factor is primarily determined by the physician staff. It is hence appropriate to consider it a short-run exogenous variable.

Bed Size

If other factors are not considered, the association between bed size and cost is generally positive. That is, large hospitals tend to have higher costs and small hospitals tend to have lower costs. However, this positive relationship usually disappears when the effects of other factors are taken into account through regression analysis. The explanation for this apparent paradox is that although large hospitals tend to have characteristics which produce higher costs, size alone is not cost-increasing. For example, large hospitals are disproportionately involved in medical education programs, and such involvement has a strong positive impact on cost. Similarly, length of stay and surgical concentration, both cost-increasing factors, tend to be higher in large hospitals.

Group I hospitals encompass a substantial range of hospital sizes. No Group I institution has less than 30 beds, but about 20% have between 30 and 50 beds. Another 20% have between 50 and 100 beds. At the other end of the size spectrum, approximately 20% of Group I hospitals have more than 300 beds. However, no Colorado hospital is larger than 600 beds. There are thus no giant hospitals in this state which have grown to a size where diseconomies of scale might be expected.

Given this size range, significant operating efficiencies can be attained by these hospitals, particularly in hotel, nursing, and administrative services. Appreciable economies of scale can also be realized in capital and ancillary services, but other factors reduce the negative influence of bed size on the costs of these services. Because of these economies of scale, bed size has a negative impact on cost, when the effects of the cost-increasing factors discussed earlier are taken into account.

Eight years frequently elapse between the initial planning of hospital expansion and the operational use of new facilities. Bed size can be reduced more rapidly, but hospital administrators and board members, physicians, and community leaders are generally reluctant to institute a major closure of hospital facilities. Thus, while minor adjustments in bed size can be made relatively quickly by the hospital, large changes in bed capacity occur only over a long time period. It is consequently appropriate to consider bed size a short-run exogenous variable.

Bed size and other types of hospital capital facilities should eventually be within the domain of a prospective payment program. A mature prospective payment program (in conjunction with a planning program) should consider both proposed changes in the bed size of individual hospitals and the size distribution of hospitals in different parts of the state. Consequently, after several years of operation, a prospective payment program should consider reclassifying bed size as an endogenous variable. If this step were taken in

the future, given the negative influence of bed size on cost, the effect would be to force smaller hospitals to justify their relatively higher costs (after the effects of other factors are taken into account).[7]

Properties of Final Cost Equation

The six determinants by themselves are responsible for approximately 90% of the variation in total cost. That is, the determinants account for 90% of the cost differences among Group I hospitals, with the remaining 10% of those differences being caused by other factors. The residual cost variation not explained by the six determinants is not produced by the other exogenous factors included in the analyses (which are described later in this chapter). Instead, this residual variation is caused by differences among hospitals in terms of endogenous variables and unique hospital circumstances.[8]

Because of the high predictive power of the final cost equation, cost comparisons based on this equation will be an effective screening tool. If the predictive power of the final equation had been substantially lower (perhaps 65%), the hospital cost comparisons would have been less satisfactory because of the justifiable concern that important exogenous factors had not been taken into account. Conversely, if the predictive power of the final equation had been markedly higher (perhaps 98%), the hospital cost comparisons would have been an ineffective screening device, since the actual costs of all hospitals would have approximated their expected costs. In this instance there would have been legitimate concern that some endogenous variables had been mistakenly classified as exogenous factors and included in the analyses.

The effects of medical education involvement, income level, long-term care involvement, length of stay, and surgical concentration are significant at beyond the .001 level in the final equation. Hence, for each of these factors the chance that its influence on cost is spurious is less than one in 1,000. The remaining variable, bed size, is solidly significant at the .05 level. In fact, although

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[7] One possible justification is the maintenance of a statewide network of hospital facilities, so that Group I hospital care will be available to the great majority of state residents on a geographically contiguous basis.

[8] As discussed in Chapter 10, one task of a prospective payment program is to distinguish between cost differences occasioned by endogenous variables and those produced by unique circumstances beyond the control of the hospital.

it is not significant at the .01 level, bed size is significant at the .02 level, indicating that the chance that its impact is spurious is less than one in 50.

Not only are the effects of the six determinants statistically significant, but they are also substantial in terms of dollar impact on cost. Among the six determinants, medical education involvement has the most powerful impact on cost. The factor with the second strongest influence is length of stay. Long-term care involvement follows as the variable with the third strongest impact on cost. The effects of income level and surgical concentration are approximately equal, being somewhat lower than that of long-term care involvement. The variable with the least powerful influence is bed size.[9]

The interrelationships among the cost determinants are termed collinearity. If collinearity is high, the regression equation becomes difficult to interpret. The overall collinearity of the final Group I equation is moderate -- far below the level required to reduce the computational accuracy of the regression equation. Collinearity involving specific cost determinants is also within acceptable bounds. It is highest for bed size and lowest for long-term care involvement.

It is important that the final cost equation predict equally well the costs of different types of hospitals. For example, within Group I the final cost equation should predict the costs of large hospitals as accurately as those of small hospitals. Similarly, it should predict the costs of hospitals with medical education programs as accurately as the costs of hospitals without such programs. In part, concern that this objective would not be realized led to the separation of Colorado hospitals into Groups I and II.

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[9] The relative power of each determinant can be assessed by examining the determinants' marginal R^2 statistics, as shown in Table 3-1 at the end of this section. It can also be assessed by determining the maximum cost contribution of each determinant. This statistic is calculated by multiplying the regression coefficient of each determinant by the difference between its maximum and minimum values (i.e., by its range). The maximum cost contribution for each determinant is shown below.

- medical education involvement: $912
- length of stay: $461
- long-term care involvement: $426
- surgical concentration: $377
- income level: $351
- bed size: -$226

The predictive accuracy of the final cost equation was examined in 12 different tests. For example, the equation's predictive accuracy for Denver SMSA hospitals was compared to its predictive accuracy for the other Group I hospitals. In none of these tests is there a significant difference in the predictive accuracy of the final equation. Consequently, the equation is applicable across the entire set of Group I hospitals.[10]

As a reference the quantitative parameters of the final cost equation are shown in Table 3-1.[11]

Table 3-1

FINAL EQUATION FOR TOTAL COST

$R^2 = 0.894$	Determinant = 0.157		Constant = -4943×10^{-1}		
Independent Variable	Regression Coefficient	t-Value	Elasticity	Marginal R^2	Covariance Ratio
Medical Education	2457×10^{0}	9.90	0.0758	0.258	0.25
Income	1071×10^{-4}	3.82	0.4956	0.038	0.39
Long-Term Care	2051×10^{-1}	4.66	0.0240	0.057	0.09
Length of Stay	1035×10^{-1}	5.46	0.7731	0.079	0.50
Surgical Concentration	7038×10^{-1}	3.81	0.3378	0.038	0.53
Bed Size	-4347×10^{-4}	-2.20	-0.0889	0.013	0.68

[10] In more technical terms, this test examines a basic assumption of regression analysis -- the assumption of variance homogeneity of the residual term. As discussed, this assumption was sustained for the final cost equation.

Another basic assumption of regression analysis is that the residual term has a normal distribution. This assumption was also tested and found to be fully satisfied by the final equation.

[11] The characteristics of the intermediate cost equations are displayed in the Technical Report.

Factors Significant in Intermediate Analyses

Farm Population

Hospitals in highly urban areas are likely to attract a complex case mix, but this effect is mediated mainly through medical education involvement and, to a lesser extent, through physician concentration, both of which tend to be high in urban areas. Similarly, hospitals in urban areas must generally pay higher prices for their labor and other inputs, but primarily because such areas usually have higher income levels. Urban/rural character thus has a substantial positive association with cost, which becomes much weaker after other factors are taken into account.

In Colorado, the factor which best represents the urban/rural character of the community is its farm population (the percentage of the county or SMSA population which is classified by the Census as being rural farm). This factor is not only influenced by the distinction between urban and rural areas, but also by the composition of the latter in terms of farm or nonfarm. The difference between rural farm and rural nonfarm is important in Colorado because nonmetropolitan counties in mountain areas tend to be nonurban and low in farm population. In contrast, nonmetropolitan counties in plains areas are also usually nonurban but have a higher farm population. Because mountain counties tend both to be more isolated and to present greater recreational opportunities, hospitals in these counties often provide more acute and definitive care than do hospitals in plains counties. As noted earlier, hospitals in metropolitan areas, where the farm population is very low, generally have a more complex case mix than either type of rural hospital.

The net result of these effects is that farm population -- a long-run exogenous variable, like income level -- has a negative influence on cost when only long-run exogenous variables are considered. However, its impact is gradually diminished by the inclusion of the short-run exogenous variables until it is reduced to insignificance by the introduction of surgical concentration. Hence, in accord with an important criterion used in the conduct of the analyses -- that all variables not significant at least at the .05 level must be removed from the cost equation[12] -- farm population is not a member of the final equation.[13]

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[12] This is one of the 14 explicit criteria applied to the cost analyses. These criteria are discussed in the Technical Report.

[13] Urban/rural character can also be represented by urban population (the percentage of the population which resides in urban areas), but as expected, in Colorado the effect of urban population on cost is weaker than the influence of farm population.

Case Severity

This factor represents differences among hospitals in terms of the severity of cases within the same diagnosis cohorts,[14] with severity being defined to encompass both the inherent seriousness of the case and the predominant nature of the services provided during treatment of the case.

As an example, consider diabetes mellitus. A patient in marked diabetic acidosis has more extensive symptoms, and thus requires more services, than a diabetic patient who is not well-controlled but is not in acidosis. The former is a more serious manifestation of the same disease, diabetes mellitus, than the latter. Alternatively, a diabetic patient in fair control may be admitted for a thorough evaluation involving study of a number of organ systems, while a similar diabetic patient may be admitted for a much more limited investigation directed primarily toward improved maintenance therapy. These two patients are receiving drastically different sets of services. In this instance it is not simply a question of a few additional tests, but rather the entire purpose of the admission is different.

Another example of a cohort in which there is a marked variation in severity is gallbladder disease. There is a major difference between patients admitted for symptomatic treatment during an acute attack and patients receiving definitive, operative treatment. Other cohorts characterized by distinct differences in severity are displaced intervertebral disc, concussion and related intracranial injuries, spinal/pelvic/lower limb fracture, and duodenal ulcer.

Like case mix, case severity is primarily determined by physicians, who decide what types of cases will be admitted, what will be their length of stay, and what services will be provided. For this reason alone it is appropriate to consider case severity and case mix short-run exogenous factors. Equally important, it is necessary to base any assessment of hospital costs partially on the types of cases treated by hospitals. The rationale is that case severity and case mix are primarily indicators of the type of output produced by the hospital. From this perspective it is also appropriate to consider these hospital characteristics exogenous factors.

Case severity has a positive influence on cost when the long-run exogenous factors and only some of the short-run exogenous variables are taken into account. However, once length of stay is brought into the analyses, the impact of case severity fades to insignificance. The rationale for the stronger influence of length of stay is twofold. It partially represents case severity. At the same

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[14] In this project diagnosis cohorts are specified in terms of three-digit ICDA codes.

time, it encompasses other factors, such as elderly caseload and utilization practices, which impact cost by influencing length of stay.

Elderly Caseload

An important dimension of the hospital's patient age mixture is its elderly caseload, i.e., the percentage of its patients aged 65 or more. The disease mixture of the elderly is different from that of the younger population. On the one hand, the aged tend to have more extensive and life-threatening conditions. On the other hand, their illnesses are frequently chronic and characterized by episodic acute exacerbations.

Hence, the relationship between elderly caseload and service intensity is not clear-cut. A large elderly caseload may indicate high service intensity if the hospital is primarily providing definitive care to the aged. However, if the hospital is mainly providing symptomatic or convalescent care to the elderly, a large elderly caseload may connote low service intensity.

Provision of definitive care to the aged is likely to entail relatively long lengths of stay. Similarly, provision of convalescent care to the aged after an acute episode of illness is usually accompanied by a long length of stay. In contrast, treatment of an acute illness of moderate severity (e.g., some types of gastrointestinal disease) is likely to involve a short length of stay. Even so, for most illnesses the length of stay of the aged is substantially longer than that of the younger population. The longer time period required by the elderly for convalescence and the greater severity of their illnesses override the tendency of physicians to admit the aged more frequently than the younger adult population for short-term acute treatment.

The age composition of a hospital's patients can be influenced by the administrative staff. For example, hospital administrators can encourage the admission and/or continued stay of elderly patients; or they can have a major voice in deciding whether the hospital should emphasize or restrict the care of pediatric patients. Nonetheless, as with case severity and length of stay, the physician primarily determines the age mixture of hospital patients. It is consequently appropriate to consider elderly caseload and the other hospital age mixture variables (middle-aged caseload and pediatric caseload) short-run exogenous variables.

Because of its length of stay effects, elderly caseload has a negative, albeit narrowly significant, impact on cost before length of stay is taken into account. However, like case severity, but to an even greater extent, once length of stay is included in the analyses the influence of elderly caseload becomes highly insignificant.

Factors Insignificant Throughout the Analyses

Case Mix

In this project case mix is defined as the aggregate intensity or costliness of acute inpatient cases. Case cohorts (e.g., normal delivery, diabetes mellitus, and asthma) are necessarily specified in terms of three-digit ICDA[15] diagnosis codes,[16] since this is the finest level of detail contained in the CBC claims data base, the source used for the case mix, case severity, and utilization practices indices. Although not as precise as four-digit diagnosis or three-digit operation codes, three-digit diagnosis codes are more specific and thus encompass more homogeneous cases than do broader groupings, such as the 17 major ICDA categories. For example, Diseases of the Digestive System, a major ICDA category, includes such disparate conditions as duodenal ulcer, cholelithiasis, acute appendicitis, and functional intestinal disorders. Each of these conditions is represented by a different three-digit diagnosis code.

Each cohort is weighted by its statewide median charge per case in the case mix index. For example, the osteoarthritis cohort is weighted by the statewide median charge per case for all Blue Cross osteoarthritis cases. Two factors primarily determine charge per case. The first is length of stay, since the higher the length of stay, the greater will be the charge per case, especially charges for nursing and hotel services (with the basic room rate being the largest of these charges). The second is the number and complexity of services provided per day to treat the cohort. This factor strongly impacts ancillary charges.

In the case mix index, cohorts are combined in such a way that if a hospital, in aggregate, treats a relatively high number of intense cases (those with a high statewide charge per case), its value on the case mix index will be high. Conversely, if most of its cases fall into the low intensity cohorts, its value on this index will be low. Defined this way, the case mix index would be expected to have a strong positive influence on cost.

However, its effect on cost is thoroughly insignificant throughout the analyses because there is very little variation in the case mix index among Group I hospitals. By a substantial margin this index has the lowest degree of variation among the short-run exogenous variables. Even compared to the long-run exogenous variables, where less variation is expected because most are county or SMSA

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[15] ICDA denotes the International Classification of Diseases.

[16] For example, the three-digit code for normal delivery is 650, and those for diabetes mellitus and asthma are respectively 250 and 493.

characteristics, the extent of variation is lower for the case mix index than for all but two factors.[17] The low degree of variation in the case mix index among Group I hospitals is an important finding in itself, since it graphically points up the limitations of characterizing case mix in terms of the three-digit ICDA diagnosis codes. The reason is that there is not sufficient homogeneity within the cohorts defined by these codes to accurately delineate differences in the types of cases treated by Colorado hospitals.

Another implication of these findings is that there may be less case mix variation among Colorado hospitals than had initially been expected. There is no question that cost per case for acute myocardial infarctions is far higher than that for tonsillectomies. However, this difference will be unimportant at the hospital level if hospitals treat similar proportions of myocardial infarctions and tonsillectomies.

Moreover, it is not necessary for hospitals to treat equal percentages of all case cohorts in order for variation in the case mix index to be low. Such a result can also occur if the distribution of high intensity cases is offset by the distribution of low intensity cases. For example, cancer of the breast is a high cost cohort, while benign neoplasm of the breast is a low cost cohort. Both cohorts occur with approximately the same frequency in the Blue Cross population. Both are likely to be concentrated in certain hospitals, with the result that the cost-increasing effect of treating malignant breast tumors is offset by the cost-decreasing influence of treating benign breast tumors. Concentration by a hospital on breast tumors is hence not likely by itself to substantially increase cost.

Utilization Practices

Style of practice is defined in this project as the predominant length of stay of patients in the same diagnosis cohort and with similar case severity. This factor is represented by the utilization practices index, which is directed toward those cohorts in which length of stay is dominated by style of practice, rather than by case severity.

There are several excellent examples of this type of cohort. One is normal delivery. By definition, if a delivery were attended by complications, it should have been so classified by the physician. Other examples are inguinal hernia, diseases of menstruation, and hypertrophy of the tonsils and adenoids. In each of these conditions, with rare exception, the only reason for admitting the patient to the hospital would be to provide appropriate operative treatment. Moreover, the severity of these conditions has little influence on the length of the necessary convalescent period.

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[17] The two factors are white population and education level, both of which are described later in this chapter.

If hospitals from different regions of the country were included in this project, the utilization practices index would probably have a significant effect on cost since there are sizeable differences in practice styles among the major regions of this country. In general, the West stands out as having a distinctly lower length of stay for the same diagnosis cohorts. However, in this exclusively Colorado study the utilization practices index has an insignificant impact on cost. The rationale is that implied above: style of practice tends to be regionally based since it is largely determined by dominant physicians in the area and by major medical education programs serving the area.

By its nature, style of practice is mainly set by the physician staff rather than by the administrative staff. It is thus appropriate to consider style of practice a short-run exogenous factor. If a prospective payment program were to work closely with a utilization review program, it might wish to modify this stance and consider style of practice an endogenous factor. The rationale is that cost differences due to this factor appear less justifiable than cost differences due to case severity or case mix. Nonetheless, unless the findings of the cost analyses were to change in the future, such a decision would be academic since style of practice has an insignificant influence on cost. Differences in utilization practices among hospitals thus do not affect the cost comparison results.

Specialized Service Mix

Hospitals provide an array of services to their patients. The great majority offer similar hotel services so that variation in these services is not a major distinguishing factor among hospitals. In contrast, the range of ancillary services varies dramatically among hospitals. The same point is true, but to a lesser extent, for nursing services.

All Group I hospitals have such basic ancillary services as surgery unit(s) and respiratory therapy, and almost all offer physical therapy and recovery room services. Hence, the presence of such services does not account for cost differences among Group I hospitals. Instead, the primary difference in the service mix of Group I hospitals is in terms of specialized services such as intensive care units, open heart surgery facilities, renal dialysis units, and therapeutic x-ray facilities.

A strong positive association exists between specialized service mix and bed size. Unlike the latter, however, the former is directly cost-increasing. Care in an intensive care unit is more expensive than care in a medical/surgical ward because of the greater array of services provided. Similarly, open heart surgery and renal dialysis patients usually require more services than more routine medical/surgical patients.

However, specialized service mix is positively related to several of the final cost determinants. Length of stay and surgical concentration are generally higher in those institutions with a greater array of specialized services. Equally important, specialized service mix tends to be higher in those hospitals involved in medical education. That is, such involvement partially influences cost by affecting specialized service mix.

The result of this network of relationships is that there is a positive association between specialized service mix and cost, but this association falls to insignificance when the effects of other factors are taken into account. Thus, the specific influence of specialized service mix on cost is much less strong than the specific effects of other factors, especially medical education involvement and length of stay.

Specialized service mix is more jointly determined by the hospital administrative and physician staffs than are such factors as case severity and length of stay, which are primarily controlled by the physician staff. A sound argument can thus be made that specialized service mix should be reclassified as an endogenous factor early in the history of a prospective payment program. Accentuating this point is the fact that specialized service mix can be changed more rapidly than bed size, which is also jointly influenced by the hospital administrative and physician staffs. However, assuming that the results of the cost analyses do not change, the reclassification of specialized service mix, like utilization practices, would be academic since its influence on cost is insignificant, after the effects of other variables are taken into account.

Middle-Aged Caseload and Pediatric Caseload

Another element of the hospital's age mixture is its middle-aged caseload, defined as that proportion of its patients between 51 and 64 years of age. Hospital care for the middle-aged usually entails a longer length of stay than it does for the younger population. Given this length of stay effect, it is uncertain whether service intensity per day is higher for the middle-aged group than for the younger population. There is no question, however, that service intensity per admission tends to be higher. For example, a 55-year-old person undergoing a cholecystectomy is likely to receive a wider array of laboratory and x-ray examinations than a 35-year-old individual having the same operation.

However, the difference between hospital care for the middle-aged and hospital care for the younger population is much smaller than that between the elderly and younger populations.[18] As a result, middle-aged caseload has an insignificant effect on cost.

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[18] For example, CPHA (1974) reports that the median length of stay for appendectomy for patients aged 50-64 years was six days, which contrasts with five days for the population 20-49 years, and nine days for patients aged 65 years or older.

The third factor representing hospital age mixture is pediatric caseload, defined as the percentage of the hospital's cases aged four years or less. It is specified in this way (i.e., exclusive of older children) to focus on the hospital care of the very young, whose disease patterns and other characteristics differ most substantially from those of the older population. Hence, its definition sharpens the contrast between pediatric and adult patients.

Pediatric cases generally have shorter lengths of stay for the same diagnoses, e.g., inguinal hernia, pneumonia, or acute bronchitis. Equally important, pediatric case mix is skewed toward illnesses with short lengths of stay, e.g., hypertrophy of tonsils and adenoids, lacerations of the head, and upper respiratory infections. The length of stay of the very young is hence shorter than that of the older population. Service intensity per day, especially in the nursing area, is probably higher for the very young, although the difference between this age group and the older population is not large. The length of stay and intensity effects of pediatric caseload are thus offsetting to a degree, which is a factor responsible for the insignificant influence of pediatric caseload on cost.

One of the Group I hospitals -- Children's Hospital in Denver -- is a specialized institution which accepts only pediatric patients. It is thus a sharp positive outlier in terms of pediatric caseload. Since the presence of this hospital could influence the analytical findings concerning pediatric caseload, the effect of this factor was examined in a supplementary analysis in which Children's Hospital was excluded. However, as in the main analyses, the influence of pediatric caseload is also insignificant in this supplementary analysis.

Emergency/Outpatient Involvement

Involvement by the hospital in emergency and outpatient care[19] (defined as the ratio of emergency and outpatient visits to acute inpatient days) is analogous from a cost-influencing perspective to involvement by the hospital in long-term care. For the same reasons as for long-term care, the costs of emergency/outpatient involvement are included in total hospital costs, but emergency/outpatient utilization is not included in acute hospital admissions, i.e., the denominator of the cost variable. It is hence possible for emergency/outpatient involvement to have a positive effect on cost.

Such an effect does not occur for several reasons. First, the cost implications for emergency/outpatient involvement are less pervasive than for long-term care involvement. Second, in Group I hospitals the volume of emergency/outpatient services is usually modest compared to the number of acute inpatient services. The ratio of

[19] The nature of hospital operating and accounting procedures prevents separate consideration of these two types of hospital services.

emergency/outpatient visits to acute inpatient days never exceeds 2.5 in any Group I hospital. As a result of these factors, emergency/outpatient involvement has an insignificant impact on cost throughout the analyses. Like long-term care involvement, it is appropriate to consider this factor a short-run exogenous variable.

Physician Characteristics

Physician concentration (number of patient care, nonfederal physicians divided by the county or SMSA population) in the community of hospital location may exert an important influence on hospital cost. A high physician concentration will probably lead to more complex case mix and to greater case severity. However, part of this case mix effect is due to location of medical education programs in areas where physician concentration is high. The effect of physician concentration is thus weaker after the influence of medical education involvement is taken into account.

Equally important, the impact of physician concentration on cost is substantially less clear-cut for Group I hospitals than the influence of another local area characteristic -- income level. Consistent with this point, the effect of income level overrides the impact of physician concentration in the analyses. It was consequently necessary to delete the latter from the cost equation.

The specialty mixture of physicians in the community of hospital location could also have an important impact on cost. In this regard the most important specialty measure is general practitioner concentration (number of general practitioners divided by the population).[20] However, general practitioner concentration does not exert a significant influence on cost.

Other Socioeconomic Factors

The age profile of the community in which a hospital is located could significantly affect the demand for hospital care. Two population age factors were included in the analyses -- elderly population (percentage of the population over 64 years of age) and pediatric population (percentage under five years of age). As discussed earlier, the very young and the old exhibit disease patterns strikingly different from each other and from the remainder of the population. However, like the corresponding hospital age mixture variables, neither of these factors has a significant influence on cost.

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[20] Both surgeon concentration and primary care physician concentration have a strong positive correlation with overall physician concentration, and so would not add significant power to the analysis. Both variables were thus excluded from the final analyses.

The American Medical Association, the data source for this variable, defines general practitioners to include family practitioners.

The community's racial composition may have an important effect on the demand for hospital care. In the Indiana Study white population (percentage of the population which is white) has a consistent negative influence on cost. However, Colorado is more homogeneous in terms of this factor than are the Midwestern states included in the Indiana Study. As a result, the white variable has an insignificant influence on cost.

In contrast to white population, there is substantially more variation across Group I hospitals in terms of Spanish-American population (percentage of the population who are persons of Spanish heritage). Even so, this factor has an insignificant influence on cost.

The community education level (median education) was included in this study since it may affect some elements of the demand for hospital care more strongly and in a different manner than income level, with which it is positively related. Nonetheless, after the impact of the latter is taken into account, the influence of the former is insignificant.

Community population change (percentage population change between 1970 and 1975) can have several effects on the hospital industry, but its most important impact is on the occupancy rate. Because of the long time period required to construct hospital facilities, rapid population growth is likely to outdistance the increase in hospital facilities, thereby leading to an increase in the occupancy rate. Conversely, since hospital administrators, board members, and community leaders are usually reluctant to close hospital facilities in areas with declining populations, such areas are likely to be characterized by a low occupancy rate.

Population change thus has a positive impact on the occupancy rate and hence a possible negative influence on cost. While this effect of population change is present among Group I hospitals, it is not sufficiently strong to make the influence of population change on cost significant. An important factor contributing to this finding is the likelihood that the occupancy rate does not have a major impact on Group I hospital costs, after the effects of other endogenous variables are considered.

Like income level and farm population, the socioeconomic factors discussed in this section cannot be significantly influenced by the actions of individual hospitals. They must consequently be considered long-run exogenous factors.

Control Type

A hospital is not likely to substantially modify its control type (e.g., from local government to nonprofit or for-profit) because of the pressures exerted by a prospective payment program. From

this viewpoint control type could be considered a long-run exogenous factor. However, as discussed in Chapter 2, CBC does not regard variation in control type as a legitimate justification for differences in cost (a position supported by CHA and Spectrum Research). Consequently, control type was excluded from the main analyses.

However, the impact of control type was examined in a supplementary analysis. Since there is only one for-profit hospital in Group I, the hospital control variable is directed toward the distinction between nonprofit and local government hospitals. This distinction is unimportant from a cost-influencing perspective in Colorado since the effect of control type is insignificant in this supplementary analysis.

Endogenous Factors

Factors such as average salary, labor productivity, capital productivity, wage level, labor skill mix, intensity of capital resources, and labor/capital ratios, may have a strong impact on costs. These factors, however, share a common characteristic. They can be significantly influenced by the hospital administrative staff within a relatively short time frame. That is, it is through such factors as these that hospital administrators can reduce their rates of cost inflation in response to the incentives of a prospective payment program. These factors must hence be considered endogenous variables, and must therefore be excluded from the analyses.

Summary

There are six final determinants of total cost in Group I hospitals: medical education involvement, income level, long-term care involvement, length of stay, surgical concentration, and bed size. The first five determinants have a positive influence on cost, while bed size has a negative impact. These six factors account for approximately 90% of the variation in total cost among Group I hospitals. The effects of all six determinants are substantial, with medical education involvement having the strongest influence. It is unlikely that the impact of any determinant is spurious. All but bed size are significant at beyond the .001 level, and bed size is significant at the .02 level.

Since its predictive accuracy is similar for different subsamples of Group I, the final cost equation is applicable across all Group I hospitals. The extent of association (collinearity) among the cost determinants is not high, and thus does not interfere with the interpretability of the equation.

Not only are the statistical properties of the final cost equation strong, but its substantive basis is solid. There is a sound rationale explaining the influence of each determinant on cost. The final cost equation thus forms a strong foundation for the hospital cost comparisons.

A number of factors other than the six determinants were considered in the analyses. Three of these factors -- farm population, case severity, and elderly caseload -- have a significant influence on cost in some of the intermediate analyses, but their effects are driven to insignificance by introduction of one or more of the final cost determinants. Fourteen other factors were included in the final analyses but had an insignificant influence on cost throughout. As stressed in the previous chapter, endogenous variables were excluded from the analyses.

Table 3-2 shows the factors included in the Group I cost analyses. It indicates for each factor whether it is a long-run or short-run exogenous variable, and whether it is a final cost determinant, a significant factor in some intermediate equations, or an insignificant factor throughout the analyses.

Table 3-2

GROUP I EXOGENOUS FACTORS

	LONG-RUN EXOGENOUS FACTORS	*SHORT-RUN EXOGENOUS FACTORS*
FINAL COST DETERMINANTS	Medical Educ. Involv. Income Level	Long-Term Care Involv. Length of Stay Surgical Concentration Bed Size
FACTORS SIGNIFICANT IN INTERMEDIATE ANALYSES	Farm Population	Case Severity Elderly Caseload
FACTORS INSIGNIFICANT THROUGHOUT ANALYSES	Physician Concentration General Pract. Concen. Elderly Population Pediatric Population White Population Spanish-American Popul. Education Level Population Change	Case Mix Utilization Practices Specialized Service Mix Middle-Aged Caseload Pediatric Caseload Emergency/Outpat. Involv.

4

Determinants of Departmental Costs in Group I Hospitals

This chapter discusses the departmental cost analyses, which are an extension of the total cost analyses in that they examine in greater detail hospital cost structures. These analyses use the same exogenous factors as do the total cost analyses. The nature of these factors is discussed in the preceding chapter. This chapter also presumes an understanding of the total cost findings presented in Chapter 3.

Unlike the preceding chapter, this chapter is organized in terms of the departmental costs rather than the exogenous variables. Its first section discusses the principles used to create the departmental cost variables and describes the nature of those variables. The next section describes the findings of the five departmental cost analyses, indicating the effects of the exogenous factors on departmental costs and the rationale for those effects. The last section compares the final departmental cost equations. It contrasts the effects of the exogenous factors on the different departmental costs, and discusses the properties of each departmental cost equation.

Construction of the Departmental Cost Variables

The departmental cost variables must satisfy three conditions in order to form a firm basis for extending the findings of the total cost analyses. First, these variables must be substantively sound. That is, the commonalities among the units in each departmental cluster must be greater than the commonalities between the units in one cluster and the units in the other clusters. Using a colloquial example, apples should be combined with apples, oranges with oranges, etc. If the departmental cost variables did not satisfy this condition, they would have no substantive basis. There would be no reason to expect a specific exogenous variable to affect one type of departmental cost more than another. Correspondingly, analyses of departmental cost measures not satisfying this condition would not be useful to a prospective payment program since they would not provide insights beyond those obtained from the total cost analyses.

The second condition is that the departmental cost variables must be relatively insensitive to variations in hospital accounting practices. This condition is likely to be violated if a hospital's smaller operating units are used as a basis to construct departmental

cost measures. For example, some hospitals include blood bank expenses in laboratory costs, while others carry such expenses as a separate cost center. This variation in hospital accounting would most strongly affect a blood bank departmental cost measure, but it would also substantially influence a laboratory departmental cost measure. In contrast, if an ancillary departmental cost measure were constructed, encompassing both laboratory and blood bank operating units (as well as other units), it would be unaffected by this variation in hospital accounting. Hence, the second condition is more likely to be satisfied by aggregate departmental cost measures which include a number of operating units having similar characteristics.

The third condition is that each cost center included in total cost must be included in one, but no more than one, departmental cost. The satisfaction of this condition ensures that for each hospital the sum of the departmental costs will equal total cost, and that the departmental costs will be mutually exclusive. No cost center will be unduly weighted because it is included in more than one departmental cost. Equally important, there will be no cost center outside the departmental cost analyses, into which hospitals could conceivably "dump" certain cost elements.

Five departmental cost variables satisfying these three conditions were created. One variable consists of the costs of those hospital units which primarily provide services encompassed within the broad definition of nursing care. Examples of such units are medical/surgical units, pediatric or OB/GYN units, and intensive care units. Because of the nature of these units, this departmental cost variable is termed nursing cost.[1] Only the direct costs of nursing-type units are included in this variable -- a principle which applies to the other departmental cost variables. That is, since each cost center is included within one of the departmental cost variables, it would be incorrect to allocate indirect costs to the direct cost centers.

The second departmental cost variable is composed of the expenses of those units which provide diagnostic or therapeutic services, but not primarily nursing care. In many hospitals there is a wide array of such units, including surgery, radiology, laboratory, pharmacy, and physical therapy. Reflecting its composition, this departmental cost variable is termed ancillary cost.

The third departmental cost variable includes the expenses of those units whose main purpose is to keep the physical plant of the hospital operating and/or to satisfy the basic needs of patients. In general, the services provided by these departments do not

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[1] Analogous to the total cost variable, each departmental cost variable is defined as departmental cost/admission.

constitute the actual delivery of medical care. Instead, these units provide services similar to those provided by a hotel in which guests eat all their meals. Accordingly, this departmental cost variable is termed hotel cost. It encompasses the costs of such units as dietary, laundry/linen, housekeeping, and plant maintenance.

The fourth departmental cost variable is made up of the costs of those units providing services common to the management or administrative function of a large institution. The administration cost center itself is included within this departmental cost variable, as are such cost centers as accounting, personnel, and medical records. In accord with the nature of its component units, it is termed administrative cost.

The fifth departmental cost variable is composed of the expenses associated with the use of capital inputs by the hospital. Such expenses cut across the other four departmental areas, and are carried as separate cost centers by hospitals. Hence, these expenses are segregated as the last departmental cost variable, which is appropriately termed capital cost. Depreciation and amortization costs and interest expenses dominate this variable.

As indicated in Table 4-1, ancillary and nursing costs are almost equal in size, each accounting for approximately 30% of total cost. Hotel and administrative costs are also nearly equal, each comprising slightly less than 20% of total cost. Both costs are thus substantially smaller than ancillary and nursing costs. Capital cost is the lowest of the departmental costs, representing only 6% of total cost.

Table 4-1

RELATIVE SIZE OF THE DEPARTMENTAL COSTS

Cost Variable	Average Value	Percentage of Total Cost
Nursing Cost	$225	28.1%
Ancillary Cost	223	27.9
Hotel Cost	158	19.8
Administrative Cost	145	18.1
Capital Cost	49	6.1
Total Cost	$800	100.0%

Effects of Exogenous Factors on Departmental Costs

Nursing Cost

Medical education involvement leads to the delivery of highly complex care. An integral part of such care is a high intensity of nursing services, ranging from cardiac nursing through specialized orthopedic nursing. As a consequence, medical education involvement has a strong positive impact on nursing cost.

Nursing cost is the most labor intensive of the five departmental costs. Income level most strongly influences hospital costs by affecting the wages paid to hospital personnel. It thus has a stronger impact on nursing cost than on the other four departmental costs.

Length of stay has a powerful positive effect on nursing cost, primarily because longer stay cases tend to be more severe. In addition, to the extent that length of stay is higher because of less constrained utilization practices, its impact on nursing cost is still positive, because while the intensity of nursing services per day declines during the convalescent stage of hospital care, it does not decrease to zero.

The impact of surgical concentration on nursing and ancillary intensity was highlighted in Chapter 3. As a consequence of this effect, this factor has a strong positive influence on nursing cost. The direct expenses of long-term care units are included in nursing cost. Since such units are often large compared to acute inpatient units in the same institution, long-term care involvement has a strong positive impact on this departmental cost.

Economies of size can be attained in the delivery of nursing services. Large hospitals have a wider range of options in the deployment of nursing resources within individual clinical units. Nursing manpower can be more effectively shifted between units in response to changes in occupancy pressure, and large hospitals can often take better advantage of labor-saving capital devices. As a result, bed size has a substantial negative influence on nursing cost.

It has been argued in the past that more nursing services are required for the care of older people -- an argument responsible for the inclusion of the "nursing differential" in the Medicare program. While it is true that the elderly require more intensive nursing care for the same conditions with the same severity, it is also true that compared to the younger population, the hospitalized elderly receive more supportive and convalescent treatment, which requires less intense nursing care. These offsetting effects contribute to the insignificant influence of elderly caseload on nursing cost.

The intensity of nursing services is generally higher for very young patients, but this effect is not sufficient to make the impact of

pediatric caseload on nursing cost significant. Emergency/outpatient involvement could have a significant influence on nursing cost, since the direct expenses of such involvement are included in this departmental cost. However, as with total cost, the influence of this factor on nursing cost is insignificant.

In short, all six total cost determinants have substantial effects on nursing cost. In fact, the influence of each determinant is stronger on nursing cost than on total cost. The difference in the two effects is only slight for long-term care involvement, but is sizeable for the other five determinants. Partially because of the powerful effects of the total cost determinants, none of the other exogenous variables has a significant impact on this departmental cost.

Ancillary Cost

As emphasized earlier, medical education involvement and surgical concentration sharply increase the intensity of ancillary services. As a consequence, both factors have powerful positive effects on ancillary cost, comparable to their influences on nursing cost.

Analogous to medical education involvement and surgical concentration, the case severity component of length of stay increases ancillary service intensity. However, its utilization practices component has little influence on such intensity. That is, stretching out the hospital stay does not appreciably increase the utilization of ancillary services, but the treatment of severe cases does. As a consequence of these varied effects, length of stay has a substantial positive impact on ancillary cost, but an impact weaker than its influence on nursing cost.

Ancillary services are less labor intensive than nursing services, although generally more labor intensive than hotel services. Service intensity, which is unaffected by income level, has a greater influence on ancillary cost than on nursing cost. Correspondingly, wage levels have a smaller impact on ancillary cost. The net result of these effects is that income level has a positive influence on ancillary cost which is smaller than its impact on nursing cost.

Long-term care patients generally consume far fewer ancillary services than do acute hospital patients. While the former may receive occupational or speech therapy, they rarely use such facilities as surgery, recovery, or nuclear medicine. Similarly, their utilization of laboratory, radiology, and even pharmacy services is less extensive than usage by acute inpatients. As a consequence, long-term care involvement has an insignificant effect on ancillary costs.

Important economies of size can be achieved in ancillary services. As ancillary volume increases, personnel with more specialized skills can be used, and employees can be utilized more fully, with less

"down time." However, the positive relationship between bed size and ancillary service intensity is stronger than those between bed size and other types of service intensity. Consequently, the former relationship is not fully represented by surgical concentration, length of stay, and medical education involvement. That is, bed size has a positive influence on ancillary service intensity, independent of the other cost determinants. As a result of these conflicting effects, bed size has an insignificant impact on ancillary cost.

Several factors other than the total cost determinants could have a significant influence on ancillary cost. Two such factors are case severity and utilization practices. The former could increase ancillary costs while the latter could decrease these costs. However, length of stay blunts the impact of case severity and is not sufficiently synergistic with utilization practices to induce a significant effect of the latter on ancillary cost. Emergency/outpatient involvement could also have a significant impact on this departmental cost, but as with nursing cost, such an impact is not present.

Middle-aged caseload usually has its strongest impact on ancillary service intensity. Even so, this effect is not large enough to make its influence on ancillary cost significant. Given that length of stay is taken into account, elderly caseload could have a negative impact on ancillary cost, since fewer ancillary services are required for convalescent or symptomatic care. However, this effect is partially offset by the elderly's consumption of large quantities of ancillary services during definitive treatment. Elderly caseload thus has an insignificant influence on ancillary cost.

Because many specialized services are ancillary services, specialized service mix could significantly influence ancillary cost, even after the effects of medical education involvement, length of stay, and surgical concentration are taken into account. Nonetheless, as with total cost, the influence of this factor on this departmental cost is insignificant.

In short, only four of the six total cost determinants have a significant impact on ancillary cost -- medical education involvement, length of stay, surgical concentration, and income level. The first three determinants have a strong influence on this departmental cost, while the latter determinant has a more modest effect. Neither long-term care involvement nor bed size has a significant impact on ancillary cost. In addition, this departmental cost is not significantly influenced by any exogenous variable which is not a total cost determinant.

Hotel Cost

Hotel costs are little affected by the nature of an illness. Consequently, regardless of its severity, if a diagnosis cohort has a longer length of stay, its hotel cost will be proportionately higher.

That is, an additional day of care for almost any reason entails approximately the same hotel expenses. As a result, length of stay has a strong positive impact on this departmental cost, which exceeds its influence on the previous two costs.

Both labor and nonlabor costs comprise substantial fractions of hotel costs. However, hotel units employ personnel whose skills are least specialized to the health care field and whose wage levels are thus closely tied to the prevailing economic condition of the community. As a result of these conflicting factors, income level has a positive impact on hotel cost, which is smaller than its effect on nursing cost but larger than its influence on ancillary cost.

Long-term care units incur many of the same hotel costs as acute hospital units. Some hotel costs are lower for long-term care units, such as central supply, and usually dietary and housekeeping. Other hotel costs, such as plant maintenance, are similar for these two types of care. Long-term care units thus generate sufficient hotel expenses to make the impact of long-term care involvement on this departmental cost substantially positive.

Hotel units are frequently cited as areas in which economies of size can be achieved. Substantial efficiencies appear possible in most hotel units, ranging from central supply through laundry/linen to dietary. As the scale of these units increases, more efficient combinations of inputs can be used; more specialized equipment can be employed; and volume discounts in the purchase of supplies and services can be more easily obtained. Bed size consequently has a negative impact on hotel cost.

Medical education involvement and surgical concentration primarily represent complexity of care and intensity of services -- factors which have less influence on hotel services than on other hospital services. As a consequence, medical education involvement has an insignificant influence on hotel cost. In contrast, surgical concentration among smaller Group I hospitals is a partial proxy for the general level of service intensity, including that of hotel services. Medical education involvement does not distinguish among smaller hospitals since it is nonexistent in them. Therefore, surgical concentration, unlike medical education involvement, has a positive impact on hotel cost, albeit an impact substantially less than its effects on nursing and ancillary costs.

Labor expenses account for approximately 60% of hospital costs. As noted earlier, capital costs comprise 6% of hospital costs. The remaining approximate one third of hospital costs is composed of the expenses of other inputs, which range from raw food through drugs to legal fees. Such expenses are termed supply/service costs.

Supply/service expenses represent a larger fraction of hotel costs than they do of the other departmental costs. It is thus possible that farm population could significantly influence hotel cost by serving as a partial proxy for the level of supply/service prices. However, at least in Colorado, farm population is a relatively inaccurate index of these prices. For example, electricity and natural gas rates are as high in farm areas as in urban areas. Food prices may be somewhat lower in farm areas, but they also tend to be lower in urban areas than in nonfarm mountainous areas. Farm population thus does not have a significant influence on hotel cost.[2]

In short, length of stay has a strong positive impact on hotel cost. Four other total cost determinants -- income level, long-term care involvement, bed size, and surgical concentration -- have significant influences on this departmental cost, but their effects are more modest than the impact of length of stay. In contrast to its effects on the other four departmental costs, medical education involvement has an insignificant influence on hotel cost. The other exogenous variables also do not have a significant impact on this departmental cost.

Administrative Cost

The extent of administrative services usually varies directly with the complexity of care delivered. Primarily for this reason, medical education involvement has a strong positive impact on this departmental cost. In addition, certain administrative expenses, such as those for medical library, medical records, and data processing, are often higher simply because of the presence of a medical education program.

Length of stay through its case severity component has a positive effect on administrative cost. However, the utilization practices component of this factor does not increase administrative cost, although the longer the length of stay for a given level of hospital utilization, the fewer the admissions to which administrative costs can be allocated. Another factor is that there is a minimum level of administrative services which must be expended on each admission. For example, each patient must be admitted and billed, and his or her medical records must be processed. Hence, as length of stay declines, administrative cost falls, but not proportionately. The result of these multiple effects is that length of stay has a

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[2] Indices denoting supply/service price levels were not available for Colorado counties and metropolitan areas. The absence of such indices has a greater effect on the hotel cost analyses than on the other four departmental cost analyses because of the relative preponderance of supply/service expenses in hotel costs. The development of nonsalary price indices was the purpose of another segment of the CBC Pilot Prospective Reimbursement Project.

positive impact on administrative cost, but an impact appreciably weaker than its effects on the previous three departmental costs.

Surgical concentration has a positive impact on administrative cost for reasons similar to those underlying its impact on hotel cost. Specifically, this factor is indicative of the general level of service intensity in smaller Group I hospitals. However, as with hotel cost, its influence on administrative cost is substantially smaller than its effects on nursing and ancillary costs.

As in the nursing and hotel areas, appreciable efficiencies of size can be attained in the administrative areas. In part these economies arise because of the wider range of options available in larger hospitals for the deployment of administrative personnel. However, a more important factor is that the larger scale of operation permits the employment of more specialized personnel. For example, a large hospital can profitably use individuals with specific training and/or experience in such areas as accounting, purchasing, and public relations. In contrast, the lower workload in a smaller hospital might necessitate the employment of a single individual to perform these varied tasks. Bed size thus has a negative impact on administrative cost comparable to its influence on hotel and nursing costs.

Administrative and management functions are generally labor intensive Many of the personnel employed in administrative units do not have skills specialized to the health care area, but others do. The net effect of these factors is that income level has a positive impact on administrative cost, but an impact lower than its influence on nursing cost.

While the administrative expenses of long-term care units are not equal to those of an acute hospital unit, they are nonetheless substantial. As a consequence, long-term care involvement has a sizeable positive impact on administrative cost.

In short, as with nursing cost, all six total cost determinants have a significant influence on administrative cost. However, only three of these determinants -- medical education involvement, long-term care involvement and bed size -- have as strong an influence on administrative cost as they have on nursing cost. The effects of the other three determinants -- income level, length of stay, and surgical concentration -- are appreciably weaker on administrative cost than on nursing cost. As is true for the previous three departmental costs, no other exogenous variable has a significant impact on administrative cost.

Capital Cost

Long-term care units are at least as capital intensive as acute hospital units. Equally important, almost all of the former were constructed during the last decade, following the inception of the

Medicaid and Medicare programs. Consequently, long-term care facilities are in most instances not yet fully depreciated. Long-term care involvement thus has its strongest influence on capital cost.

An array of equipment and facilities is necessary for the delivery of complex care, especially tertiary hospital care. Transplant surgery, open heart surgery, renal dialysis, and therapeutic radiology are all examples of specialized services which are more capital intensive than routine medical/surgical care. Medical education involvement therefore has a strong positive impact on capital cost.

For similar reasons, the case severity component of length of stay tends to increase capital cost. Further, for a given level of total hospital utilization, a longer length of stay means that capital costs are spread over fewer admissions. However, length of stay exerts a positive influence on the occupancy rate, which reduces capital cost. Consequently, length of stay has a positive influence on capital cost, but an impact less strong than its effect on hotel and nursing costs.

Equipment prices in different parts of Colorado are essentially invariant to community income levels. Construction costs are more accurately represented by income level, but the association between land prices and income level is only modest. Income level thus does not systematically reflect the prices of capital inputs, and as a result, has an insignificant influence on this departmental cost.

Large hospitals are generally more capital intensive than small hospitals. They are more likely to employ debt financing and incur higher interest costs. Their more sophisticated accounting techniques generally result in the more rapid depreciation of assets, which may cause capital expenses to appear higher, especially for recently purchased equipment. Offsetting these effects, there are substantial economies of size in capital usage, as there are in other hospital areas. These economies arise primarily because the occupancy rate is usually higher in large hospitals. The net result of these conflicting factors is that bed size has an insignificant influence on capital cost.

Surgical concentration increases capital expenses through its impact on service intensity. Countering this effect is the strong positive relationship between surgical concentration and the occupancy rate, especially in smaller hospitals. As a consequence of these opposing factors, surgical concentration has an insignificant impact on this departmental cost.

Land prices, and perhaps even construction costs, are more accurately represented by farm population than by income level. In general, the upward gradient in Colorado land prices goes from rural farm through rural nonfarm to urban. Rural hospitals are less likely to employ debt financing than urban hospitals. Equally important,

during the last 20 years rural hospitals have more frequently been the beneficiaries of the Hill-Burton program. In addition, the case mix effect of farm population will tend to decrease capital costs.

Offsetting these negative effects on capital expenses, farm population exerts a negative influence on the occupancy rate, which increases capital costs. However, its effect on the occupancy rate is less strong than that of surgical concentration. As a result, the occupancy effect of farm population is not large enough to override its other effects on capital cost. Consequently, farm population has a negative influence on this departmental cost.

It seems probable that in areas of expanding population, hospitals would have more recently added to their plant and equipment. If so, population change should have a positive impact on capital cost, since as a general rule the younger the age of plant and equipment, the greater its annual depreciation. However, opposing this effect is the positive influence of population change on the occupancy rate. These two effects are sufficiently conflicting to make the impact of population change on capital cost insignificant.

Specialized services are generally capital intensive, as noted above, and are usually recent in origin. In some instances their installation may have been covered by debt financing. It is thus possible that specialized service mix might have a positive effect on capital cost. However, this factor is positively associated with the occupancy rate, which offsets its otherwise positive effects on capital expenses. Equally important, the influence of this factor is well represented by two total cost determinants -- medical education involvement and length of stay -- both of which have a significant influence on capital cost. Consequently, as with total and ancillary costs, specialized service mix has an insignificant influence on this departmental cost, after the effects of other factors are taken into account. For analogous reasons case severity has an insignificant impact on capital cost.

In short, long-term care involvement and medical education involvement have strong effects on capital cost. Length of stay also has a significant influence, but its impact is more modest. The other three total cost determinants -- income level, surgical concentration, and bed size -- have an insignificant impact on capital cost. Unlike the other four departmental costs, a factor which is not a total cost determinant -- farm population -- has a significant impact on capital cost. Its influence is negative. However, other exogenous variables do not have a significant effect on this departmental cost.

Comparison of the Departmental Cost Equations

Medical education involvement has a similar influence on nursing, ancillary, and administrative costs -- an influence greater than its impact on total cost.[3] In partial contrast, its effect on capital cost approximates its impact on total cost. Its effect on the remaining departmental variable, hotel cost, is insignificant.

Income level has a strong influence on nursing cost, which is substantially higher than its impact on total cost. Its effect on hotel cost approximates its influence on total cost. This factor's effects on ancillary and administrative costs are similar, and lower than its impact on total cost. Income level has an insignificant influence on capital cost.

Long-term care involvement has a strong impact on capital cost, which is much greater than its influence on total cost. Its influence on administrative cost is higher than its impact on nursing cost, which is in turn greater than its effect on hotel cost. However, its effects on these three departmental costs are all within the same general range as its impact on total cost. It has an insignificant influence on ancillary cost.

Length of stay is the only exogenous factor which has a significant impact on all five departmental costs. Its strongest influence is on hotel and nursing costs, with its impact on the former exceeding its effect on the latter. Its effects on both these departmental costs are greater than its impact on total cost. The effect of length of stay on capital cost approximates its influence on total cost. Its impact on ancillary cost is greater than its influence on administrative cost, with its effects on these costs being lower than its impact on total cost.

Surgical concentration has strong and similar effects on nursing and ancillary costs which exceed its impact on total cost. Its effects on hotel and administrative costs are also similar, but weaker than its impact on total cost. Surgical concentration has an insignificant influence on capital cost.

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[3] In this section the effects of each determinant on the departmental and total costs are compared in relative, not absolute, terms. Hence, the finding reported here is that medical education involvement has a greater percentage impact on nursing, ancillary, and administrative costs than on total cost. In absolute terms (i.e., in total dollars), this factor's impact on total cost is naturally greater than its effects on the three departmental costs, since the former is much larger than any of the latter.

Bed size has similar effects on nursing, hotel, and administrative costs, which exceed its impact on total cost. It has an insignificant influence on ancillary and capital costs.

Only one factor that is not a total cost determinant has a significant influence on any departmental cost. This factor is farm population, which has a negative impact on capital cost. Its effects on the other four departmental costs are insignificant. Its impact on capital cost is substantially higher than its influence on total cost in those intermediate cost equations in which it appears.

Table 4-2 summarizes these discussions by showing the departmental and total cost determinants. In this table a plus or a minus indicates the direction of a determinant's impact on a cost, and the number of pluses or minuses denotes the approximate strength of that impact. Accordingly, a zero means that the impact is insignificant. This table primarily portrays the relative influence of the same determinant on different costs, but it also reflects the relative impact of different determinants on the same cost.

Table 4-2

DETERMINANTS OF TOTAL AND DEPARTMENTAL COSTS

	Total Cost	Nursing Cost	Ancil. Cost	Hotel Cost	Admin. Cost	Capital Cost
Medical Educ. Involv.	++++	+++++	+++++	0	+++++	++++
Income Level	++	+++	+	++	+	0
Long-Term Care Involv.	++	++	0	++	+++	+++++
Length of Stay	+++	++++	++	+++++	+	+++
Surgical Concentration	++	+++	+++	+	+	0
Bed Size	-	--	0	--	--	0
Farm Population	0	0	0	0	0	---

The differential effects of the seven determinants on the departmental costs are highly consistent with the substantive framework of these analyses. This finding not only enhances these analyses, but also the total cost analyses, since the rationale for the influence of the determinants on total cost is premised on their expected effects on departmental costs. For example, it is argued in Chapter 3 that surgical concentration has a positive impact on total cost mainly because of its positive influence on nursing and ancillary service

intensity. The results of the departmental cost analyses provide solid support for this contention. Similarly, the preceding chapter maintained that the primary rationale for the positive impact of income level on total cost is the positive influence of the former on hospital labor expenses. The differential effects of income level on the departmental costs support this rationale.

The predictive power of the nursing cost equation is 92%, which is slightly higher than the predictive power of the total cost equation, 89%. The predictive power of the ancillary cost equation is lower, but still high at 81%. The same is true for the predictive power of the administrative cost equation -- 76%. However, the predictive power of the other two departmental cost equations is appreciably lower, equalling 59% for capital cost and 51% for hotel cost.

As in the total cost equation, the effect of each variable in the departmental cost equations is significant at least at the .05 level. This means that for each departmental cost determinant the chance that its impact is spurious is no higher than one in 20. Although the significance levels of the determinants in the departmental cost equations vary, such variations are in accord with the substantive framework. For example, in the ancillary cost equation the impact of medical education involvement is significant at far beyond the .001 level; the effects of length of stay and surgical concentration are significant at slightly beyond the .001 level; and the influence of income level is significant at the .05 level.

In no instance is the collinearity of a departmental cost equation greater than the collinearity of the total cost equation.[4] Since they have the same determinants, the collinearity of the nursing and administrative cost equations is precisely the same as that of the total cost equation. The collinearity of the hotel cost equation is slightly lower than that of the total cost equation, and the collinearity of the ancillary cost equation is substantially lower. The capital cost equation has even less collinearity than the ancillary cost equation.

Twelve tests were used to examine the predictive accuracy of the departmental cost equations. Like the total cost equation, the predictive accuracy of the nursing and capital cost equations is similar across Group I hospitals. The degree of predictive accuracy across these hospitals is less similar for the administrative cost equation, but this equation still partially satisfies the predictive accuracy objective. The dissimilarity in predictive accuracy across Group I hospitals is highest for the ancillary and hotel cost

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[4] As described in Chapter 3, collinearity is defined as the degree of association among the determinants (or independent variables) in the equation.

equations, so that these equation do not formally satisfy the predictive accuracy objective. Nonetheless, even for these equations, the degree of predictive accuracy is not strikingly divergent for different segments of the Group I sample.[5]

Overall, the characteristics of the departmental cost equations are solid. In fact, since variation idiosyncratic to individual hospitals is necessarily higher for the departmental costs than for total cost, the properties of the departmental cost equations are surprisingly strong. They thus provide firm support to the total cost analyses in two ways. First, they strengthen the substantive framework of the entirety of the cost analyses. Second, they constitute a solid basis for the calculation of the departmental cost comparisons, which are designed to provide valuable insights about the total cost comparison results.

As a reference, the quantitative parameters of the departmental and total cost equations are shown in Table 4-3.[6]

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[5] As noted earlier, a related objective of regression analysis is that the residual term should have a normal distribution. As with the total cost equation, this assumption is satisfied by all five departmental cost equations.

[6] Intermediate departmental cost equations are presented in the Technical Report.

Table 4-3

COMPARISON OF THE TOTAL AND DEPARTMENTAL COST EQUATIONS

	Final Total Cost Equation	Final Nursing Cost Equation	Final Ancillary Cost Equation	Final Hotel Cost Equation	Final Adminis. Cost Equation	Final Capital Cost Equation
R^2	0.89	0.92	0.81	0.51	0.76	0.59
Determinant	0.16	0.16	0.52	0.21	0.16	0.75
Constant	-49×10^{1}	-22×10^{1}	-13×10^{1}	-11×10^{1}	-24×10^{0}	11×10^{0}
Independent Variables						
Medical Education						
regression coefficient	25×10^{2}	85×10^{1}	87×10^{1}		58×10^{1}	16×10^{1}
t-value	9.90	11.74	7.50		8.04	3.41
elasticity	0.076	0.094	0.096		0.099	0.079
marginal R^2	0.258	0.277	0.256		0.388	0.115
covariance ratio	0.25	0.25	0.22		0.25	0.16
Income						
regression coefficient	11×10^{-2}	42×10^{-3}	24×10^{-3}	21×10^{-3}	16×10^{-3}	
t-value	3.82	5.09	1.79	2.30	2.00	
elasticity	0.496	0.687	0.392	0.490	0.416	
marginal R^2	0.038	0.052	0.015	0.063	0.024	
covariance ratio	0.39	0.39	0.37	0.35	0.39	
Long-Term Care						
regression coefficient	21×10^{1}	63×10^{0}		32×10^{0}	48×10^{0}	38×10^{0}
t-value	4.66	4.88		2.19	3.72	4.55
elasticity	0.024	0.026		0.019	0.031	0.073
marginal R^2	0.057	0.048		0.057	0.083	0.204
covariance ratio	0.09	0.09		0.08	0.09	0.03
Length of Stay						
regression coefficient	10×10^{1}	35×10^{0}	24×10^{0}	27×10^{0}	12×10^{0}	61×10^{-1}
t-value	5.46	6.23	3.51	4.30	2.20	2.09
elasticity	0.773	0.917	0.646	1.024	0.499	0.747
marginal R^2	0.079	0.078	0.056	0.220	0.029	0.043
covariance ratio	0.50	0.50	0.12	0.49	0.50	0.19
Surgical Concentration						
regression coefficient	70×10^{1}	23×10^{1}	25×10^{1}	12×10^{1}	10×10^{1}	
t-value	3.81	4.24	3.46	1.97	1.93	
elasticity	0.338	0.391	0.434	0.294	0.274	
marginal R^2	0.038	0.036	0.054	0.046	0.022	
covariance ratio	0.53	0.53	0.31	0.52	0.53	
Bed Size						
regression coefficient	-43×10^{-2}	-17×10^{-2}		-14×10^{-2}	-13×10^{-2}	
t-value	-2.20	-2.99		-2.18	-2.31	
elasticity	-0.089	-0.126		-0.146	-0.150	
marginal R^2	0.013	0.018		0.057	0.032	
covariance ratio	0.68	0.68		0.67	0.68	
Farm						
regression coefficient						-10×10^{1}
t-value						-2.08
elasticity						-0.118
marginal R^2						0.043
covariance ratio						0.12

5

Determinants of Total Cost in Group II Hospitals

This chapter discusses the Group II total cost analyses, which were conducted in a manner similar to the Group I total cost analyses. It assumes a familiarity with the preceding two chapters, especially Chapter 3. Accordingly, it concentrates on the differences between Group I and Group II hospitals. As indicated in Chapter 2, departmental cost analyses are inapplicable to Group II hospitals.

The structure of this chapter resembles that of Chapter 3. Its first section addresses the four determinants of total cost in Group II hospitals, and its second section discusses the properties of the final Group II cost equation. The third section describes the single factor that has a significant influence on cost in some of the intermediate equations, but that is not a final cost determinant. The fourth section is directed toward those factors which have an insignificant influence on cost throughout the analyses.

This chapter's fifth section departs from the format of Chapter 3 since it identifies the factors included in the Group I analyses which were not applicable to the Group II analyses. The final section of this chapter is analogous to that of Chapter 3; it concisely summarizes the findings of the Group II analyses.

Final Cost Determinants

Long-Term Care Involvement

This factor has a strong positive impact on Group I hospital costs. It has an even more powerful influence on Group II hospital costs, since long-term care involvement is much more pervasive in Group II hospitals. Unlike Group I institutions, but as expected, long-term care involvement in these hospitals encompasses only skilled nursing facility care.

On average, long-term care involvement (long-term patient days divided by acute inpatient days) equals .94 in Group II hospitals. This finding contrasts sharply with the average of .09 for this variable in Group I hospitals. Average long-term care involvement is thus ten times greater in Group II hospitals than in Group I institutions. Equally striking, the average Group II hospital has almost as many long-term patient days as acute inpatient days. In fact, almost one quarter of Group II hospitals have more than three times as many long-term

patient days as acute inpatient days. In contrast, only slightly more than 10% of Group I institutions are involved in any type of long-term care.[1]

General Practitioner Concentration

Group II hospitals are small, noncomplex institutions. In most instances their medical staffs are dominated by general practitioners. General practitioner concentration is thus more specific than overall physician concentration to Group II hospitals. Further, since the great majority of physicians who are not general practitioners practice almost exclusively in Group I hospitals, the physician concentration variable is misleading for those Group II institutions located in the same counties as Group I hospitals. Because there are six such hospitals,[2] this variable was not used in the Group II analyses.

Thus, general practitioner concentration for Group II hospitals is analogous to physician concentration for Group I hospitals. However, the former has a stronger impact on Group II hospital costs than the latter has on Group I hospital costs. The rationale is that Group II hospitals located in counties with high concentrations of general practitioners are likely to provide more definitive, and thus more expensive, care than institutions situated in counties with low concentrations of general practitioners. That is, the former hospitals are generally characterized by a more complex case mix and a higher service intensity than the latter institutions.

Physician concentration is important to Group I institutions, but in most instances the critical threshold of physician concentration has been exceeded. As a consequence, the type of care provided by the hospital is more dependent on hospital characteristics than on the relative number of physicians in the county. In contrast, general practitioner concentration across Group II hospitals is much lower than physician concentration across Group I hospitals. Hence, for Group II hospitals the availability of general practitioners is often as important a cost determinant as the characteristics of the hospital.

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[1] These findings must be tempered by the recognition that more than two thirds of Group II hospitals are not involved in long-term care. Average long-term care involvement is nonetheless high, because those institutions involved in this type of care are deeply involved, as indicated above.

[2] The Group II institutions located in the same counties as Group I hospitals are Memorial (Weld), Pioneers Memorial (Otero), Clagett Memorial (Garfield), East Morgan County (Morgan), Plateau Valley (Mesa), and Lower Valley (Mesa).

The occupancy rate has a much stronger impact on cost in Group II hospitals where it is far lower than in Group I institutions. In Group II hospitals it averages 44%, compared to 71% in Group I institutions. It is thus essential to consider possible occupancy effects in evaluating the determinants of Group II hospital costs.

General practitioner concentration could increase the occupancy rate since physician availability usually draws patients to the hospital. However, its influence on the occupancy rate is insignificant. Therefore, no occupancy effect offsets the service intensity and case mix effects of this factor, and as a result, general practitioner concentration has a strong positive impact on Group II hospital costs.

Elderly Caseload

Group II hospitals rarely provide definitive care for severe conditions, which has several important implications in terms of the aged. First, elderly caseload is higher in Group II hospitals than in Group I institutions. On average, 30% of a Group II hospital's admissions are elderly, while only 22% of a Group I hospital's admissions are elderly. The primary reason for this difference is that the elderly frequently require symptomatic care, which is the main type of care delivered by Group II hospitals.

Second, a high elderly caseload in Group II institutions can be interpreted less ambiguously in terms of its impact on costs. In the Group I analyses the relationship between elderly caseload and service intensity is uncertain. If a hospital were mainly delivering definitive care to the aged, this relationship would be positive; if a hospital were primarily providing symptomatic care, this relationship would be negative. A polarity could thus arise between a hospital providing mainly symptomatic care to the aged and a hospital providing primarily definitive care to the nonaged. In the former, length of stay would be long, but service intensity low. In the latter, service intensity would be high, but length of stay low. Hence, cost might be approximately the same in these two hospitals -- one with a high elderly caseload and the other with a low elderly caseload.

In contrast, Group II institutions do not deliver definitive care for complex conditions. Therefore, the distinction for these hospitals is between providing symptomatic care to the nonaged and providing symptomatic care to the aged. However, as in Group I hospitals, the length of stay of the aged is likely to be longer than that of the nonaged. Since service intensity for the two age groups is similar, cost is likely to increase as elderly caseload rises. This positive influence of elderly caseload on cost is enhanced in Group II hospitals by their greater concentration on the care of the aged.

As stressed earlier, it is important to consider the occupancy effects of the factors included in the Group II analyses. On the one hand,

elderly caseload may increase the occupancy rate through its positive impact on length of stay. On the other hand, elderly caseload may be high in those areas where the demand for Group II hospital care by the nonaged is low. That is, elderly caseload may be high because nonelderly caseload is low. The net result of these two effects is that elderly caseload has an insignificant impact on the occupancy rate. As with general practitioner concentration, no occupancy effect offsets the otherwise positive effects of elderly caseload on cost. Consequently, elderly caseload has a strong positive influence on Group II hospital costs.

Bed Size

This factor has a negative influence on Group I total cost because of its impact on nursing, hotel, and administrative costs. Since all Group II hospitals have an average daily census under 20, there is less variation in bed size for these hospitals than for Group I institutions. This characteristic of bed size moderates its influence in the Group II analyses.

Nonetheless, substantial economies of scale can still be attained across the bed size range formed by Group II hospitals. The minimum size for these hospitals is six beds and the maximum is 54 beds, with the average size approximating 25 beds. In most instances it is distinctly inefficient to operate extremely small hospitals which contain ten, 15, or even 20 beds.[3] Bed size therefore has a negative impact on Group II hospital costs.

Properties of Final Cost Equation

The four determinants account for 80% of the variation in Group II hospital costs. While the predictive power of the Group II total cost equation is thus lower than that of the Group I total cost equation (89%), it is nonetheless sufficiently high to enable the cost comparisons based on this equation to be an effective cost assessment tool.

As in the Group I total and departmental cost analyses, the effects of the four Group II cost determinants are significant at least at the .05 level. Specifically, long-term care involvement is significant at far beyond the .001 level. General practitioner concentration and elderly caseload are both significant at the .01 level, while bed size is significant at the .05 level. Hence, the chance is less than one in 1,000 that the influence of long-term care involvement is spurious; and the chance is less than one in 20 that the impact of bed size is spurious.

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[3] As indicated in Chapter 3, a possible justification for small hospitals is geographic dispersion of hospital resources.

Long-term care involvement has the strongest influence on cost. In terms of a single factor accounting for variation in cost,[4] long-term care involvement has an even more powerful impact on Group II hospital cost than medical education involvement has on Group I hospital cost. The effects of general practitioner concentration and elderly caseload on Group II hospital cost are of approximately the same magnitude. Both these factors have a stronger impact on cost than does bed size, which is the least powerful of the Group II cost determinants.[5]

The collinearity[6] of the final Group II equation is low, both in terms of overall collinearity and collinearity involving individual cost determinants. As in the Group I total cost equation, the latter is highest for bed size. It is lowest for general practitioner concentration and elderly caseload.

The predictive accuracy of the Group II equation was examined in 11 separate tests. Analogous to the Group I total cost equation, the predictive accuracy of this equation is similar across Group II hospitals. For example, this equation predicts the costs of small Group II hospitals as well as those of larger Group II institutions. Therefore, this equation is applicable across Group II hospitals.[7]

As a reference, the quantitative characteristics of the final equation are displayed in Table 5-1.[8]

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[4] Such variation is measured by the marginal R^2 statistic, which is shown in Tables 5-1 and 3-1.

[5] The maximum cost contribution (a statistic whose calculation is described in Chapter 3) for each of the four determinants is indicated below.

- long-term care involvement: $565
- general practitioner concentration: $245
- bed size: -$211
- elderly caseload: $199

Thus, in terms of this statistic the influence of elderly caseload is less strong than that of bed size. However, the effects of all four determinants are substantial in dollar terms.

[6] As indicated earlier, collinearity is the degree of association among the cost determinants.

[7] As in the Group I equations, the related assumption of regression analysis that the residual term should be normally distributed is satisfied by the Group II equation.

[8] The Group II intermediate cost equations are shown in the Technical Report.

Table 5-1

FINAL EQUATION FOR TOTAL COST

$R^2 = 0.796$	Determinant = 0.748		Constant = 4109×10^{-1}		
Independent Variable	Regression Coefficient	t-Value	Elasticity	Marginal R^2	Covariance Ratio
Long-Term Care	7504×10^{-2}	6.61	0.1056	0.425	0.19
GP Concentration	3487×10^{-3}	2.85	0.1895	0.079	0.07
Elderly Caseload	5650×10^{-1}	2.66	0.2516	0.069	0.08
Bed Size	-4388×10^{-3}	-1.83	-0.1644	0.033	0.21

Factors Significant in Intermediate Cost Analyses

Population Change

Community population change primarily affects hospital costs by exerting a positive influence on the occupancy rate. It has a stronger impact on Group II hospitals than on Group I institutions for two reasons. First, there is more variation in community population change among Group II hospitals than among Group I hospitals. Second, as emphasized earlier, the occupancy rate has a stronger influence on costs in Group II hospitals than in Group I hospitals.

Population change has a negative impact on Group II hospital costs when only the long-run exogenous factors are taken into account. However, when elderly caseload is brought into the analyses, the impact of population change on cost is driven to insignificance. Population change thus occupies a position in the Group II analyses analogous to that of farm population in the Group I total cost analyses. In each instance inclusion of the short-run exogenous variables reduces a previously significant impact to insignificance.

Factors Insignificant Throughout the Analyses

Length of Stay

As in Group I hospitals, the direct influence of length of stay on cost is positive in Group II institutions. That is, other factors being equal, the longer the length of stay, the higher costs will be. However, to a greater extent than in Group I institutions, a rise in length of stay among Group II hospitals is likely to increase the occupancy rate, which has a negative effect on cost. Significant conflict may thus arise in the Group II analyses between the direct and occupancy effects of length of stay.

As discussed earlier, elderly caseload has an insignificant influence on the occupancy rate. Equally important, elderly caseload has a much stronger positive relationship with length of stay in Group II hospitals than in Group I institutions. Further, as indicated above, length of stay has a positive effect on the occupancy rate. Therefore, length of stay of the nonelderly population must be primarily responsible for the positive effect of length of stay on the occupancy rate.

It is thus that portion of length of stay not occasioned by the elderly which is most strongly affected by the conflict between the direct and occupancy effects of length of stay. Consequently, length of stay has a weaker influence on Group II hospital costs than does elderly caseload. Further, when the influence of the latter is taken into account, the impact of length of stay on cost is insignificant. Hence, unlike Group I, length of stay is not a cost determinant for Group II.

Income Level

This factor has a strong positive impact on Group I hospital costs. The primary rationale is that it represents the prevailing economic conditions of the community, which directly impact the prices hospitals pay for many of their resources, especially labor. On this basis, income level should also have a positive influence on Group II hospital costs.

However, most high income counties in the state are included only in the Group I analyses, and several low income counties are also included in those analyses. In contrast, Group II hospitals are more homogeneous in terms of county income level.

As a result, the extent of variation in income level is approximately half as great for Group II hospitals as for Group I institutions. In fact, with the single exception of education level, the degree of variation is lower for income level than for any of the other Group II exogenous factors. Income level therefore does not have a significant influence on Group II hospital costs.

Surgical Concentration

As in Group I hospitals, surgical concentration has a cost-increasing effect in Group II institutions because of its positive influence on the intensity of ancillary, nursing, and other services. However, to a greater extent than in Group I institutions, surgical concentration has a strong positive impact on the occupancy rate in Group II hospitals. In fact, surgical concentration has the most powerful influence of all the exogenous factors on the occupancy rate.

In Group II institutions a relatively high surgical concentration usually denotes an active hospital. A mountain hospital with a high surgical index is generally treating a large proportion of acute

injuries, which often produces a relatively high occupancy rate. A plains hospital with a high surgical concentration is usually involved in the provision of definitive care, and hence has a relatively high occupancy rate. Conversely, a very low surgical concentration often implies the absence of active physicians and the lack of provision of definitive care, which results in a low occupancy rate.

The intensity and occupancy effects of surgical concentration thus offset each other, with the conflict between these effects being even stronger for this factor than for length of stay. As a consequence, although surgical concentration is a determinant of Group I hospital costs, it has an insignificant influence on Group II hospital costs.

Basic Service Mix

For Group I hospitals the service mix variable is directed toward specialized services -- a focus inappropriate for Group II institutions. Instead, the service mix index for these hospitals emphasizes basic hospital services, such as surgery, respiratory therapy, and physical therapy. Such services are not uniformly found in Group II hospitals, and thus their presence or absence can influence Group II hospital costs.

Basic service mix could substantially increase the complexity of care and thus produce a rise in hospital cost. Or basic service mix could increase the activity level of the hospital, with a resultant rise in the occupancy rate, and a concomitant decline in cost. Basic service mix could thus be analogous to surgical concentration. That is, its net effect on cost could be insignificant because of strong but offsetting effects on the complexity of care and the occupancy rate.

However, this finding is not present. Basic service mix is insignificantly related to the occupancy rate. Equally important, in the Group II hospital environment the breadth of services offered usually has less influence on the complexity of care than does the availability of general practitioners. Hence, basic service mix has an insignificant influence on Group II hospital cost because of its modest effects on hospital behavior.

Farm Population

In the Group I analyses farm population has a negative influence on capital cost. It also has a negative effect on total cost when only the long-run exogenous variables are considered -- an effect which remains significant until surgical concentration is included in the analyses.

Much of the impact of farm population in the Group I analyses stems from its approximate three-tiered representation of the state -- plains nonmetropolitan (high farm and high rural nonfarm) to mountain

nonmetropolitan (modest farm and high rural nonfarm) to metropolitan (low farm and high urban). In the Group II analyses the last tier is absent. Only Memorial Hospital in Greeley is in a metropolitan area, and Greeley's value for the farm variable is 15%, which far exceeds the .6% of Denver and the .5% of Colorado Springs. In fact, two thirds of Group I hospitals are located in communities with a lower farm population than the minimum value for this variable (7%) among Group II hospitals. As a consequence, farm population has an insignificant influence on Group II hospital costs.[9]

Other Factors

Neither middle-aged caseload nor pediatric caseload has a significant effect on Group I hospital costs, a finding paralleled in the Group II analyses. Hospital care for the middle-aged is somewhat different than that for the younger population, but not sufficiently so to produce a significant effect on costs. The cost-decreasing effect produced by the shorter length of stay of pediatric patients is blunted by the negative effect of pediatric caseload on the occupancy rate. These conflicting effects of pediatric caseload reduce its impact on Group II hospital costs to insignificance.

In contrast to long-term care involvement, the influence of emergency/outpatient involvement is thoroughly insignificant throughout the Group I total and departmental cost analyses. Similarly, this factor has an insignificant influence on Group II hospital costs. Contributing to this result is the finding that there is less variation in emergency/outpatient involvement among Group II hospitals than among Group I institutions.

Four socioeconomic factors -- elderly population, pediatric population, Spanish-American population, and education level -- have an insignificant influence on costs in the Group I analyses. These factors also have an insignificant impact on Group II hospital costs.

As in the Group I analyses, the influence of control type was examined in a supplementary analysis. Again, its effect on cost is insignificant.

Factors Not Included in the Group II Analyses

It was not possible to construct the case severity and utilization practices indices for Group II institutions because these hospitals treat too few patients in the diagnosis cohorts included in these indices. This finding was strongly anticipated for the case severity index. It was not unexpected for the utilization practices index, but was slightly surprising, since the cohorts in this index are common.

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[9] Urban population also has an insignificant influence on Group II hospital costs.

The parameter used to weight the diagnosis cohorts in the case mix index is the statewide median charge per case for each cohort. This parameter is strongly dominated by Group I hospital experience. As a consequence, and given the differences between Group I and Group II hospitals, the statewide median charge per case is not applicable to Group II institutions. To construct the Group I case mix index for Group II hospitals would thus be invalid.

An attempt was made to use the CBC claims data to develop a different type of case mix index for Group II hospitals, which would measure the degree to which such hospitals provide definitive, as opposed to symptomatic, care. However, this index proved unsatisfactory largely because many Group II institutions treat very few patients falling within the cohorts of the case mix data base.

Medical education involvement has a strong impact on Group I hospital costs. This factor was necessarily excluded from the Group II analyses, since no Group II hospital is involved in medical education (as this factor is defined in this project).

White population has an insignificant influence on Group I hospital costs. The low degree of variation in white population across Group I hospitals is at least partially responsible for this result. The extent of variation in this factor is even lower for Group II hospitals, and consequently it was removed from the Group II analyses.

Physician concentration was excluded from these analyses for the reason discussed earlier: it is an inappropriate variable for those Group II hospitals situated in the same counties as Group I hospitals. The only other difference between the Group I and II exogenous variable sets is the substitution of basic service mix for specialized service mix, which was also described earlier in this chapter.

Summary

There are four final determinants of total cost in Group II hospitals: long-term care involvement, general practitioner concentration, elderly caseload, and bed size. The latter determinant has a negative influence on cost, and the other three determinants have positive effects. Bed size and long-term care involvement are final cost determinants for both Group I and Group II; general practitioner concentration and elderly caseload are final cost determinants for only Group II; and medical education involvement, income level, length of stay, and surgical concentration are final cost determinants for only Group I. The dissimilarity in the cost determinants supports the division of Colorado hospitals into Groups I and II.

There is a solid rationale explaining the impact of each determinant on Group II hospital costs. Equally important, there are sound reasons accounting for the insignificant effects of other exogenous factors on cost. Thus, the substantive framework of the Group II analyses is strong.

The four determinants alone explain 80% of the variation in Group II hospital costs. The effect of each determinant is significant at least at the .05 level. Each determinant has a sizeable influence on cost in dollar terms, with long-term care involvement having the most powerful effect.

The final equation is applicable across all Group II hospitals since its predictive accuracy is similar for different segments of Group II. The degree of association (collinearity) among the cost determinants is low, and thus does not pose an analytical problem.

Like the Group I cost equation, the characteristics of the Group II equation are sound.[10] This is an especially strong result since small, noncomplex hospitals like those in Group II have not been studied as extensively as larger hospitals, such as those in Group I. As a consequence of its solid properties, the final Group II equation represents a firm basis for the subsequent cost comparisons.

In addition to the four final cost determinants, a number of other exogenous factors were included in the Group II analyses. Only one -- population change -- had a significant influence on cost in the intermediate equations. Its effect was reduced to insignificance by the introduction of elderly caseload. Some exogenous factors used in the Group I analyses were not employed in the Group II analyses because they are inapplicable to Group II hospitals.

Table 5-2 indicates the exogenous factors utilized in the Group II analyses. Analogous to Table 3-2, it shows for each factor whether it is a long-run or short-run exogenous variable, and whether it is a final cost determinant, a significant factor in some intermediate equations, or an insignificant factor throughout the analyses.

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[10] As does the Group I equation, the Group II equation satisfies all 14 of the explicit analysis criteria mentioned earlier.

Table 5-2

GROUP II EXOGENOUS FACTORS

	LONG-RUN EXOGENOUS FACTORS	*SHORT-RUN EXOGENOUS FACTORS*
FINAL COST DETERMINANTS	General Pract. Concen.	Long-Term Care Involv. Elderly Caseload Bed Size
FACTORS SIGNIFICANT IN INTERMEDIATE ANALYSES	Population Change	
FACTORS INSIGNIFICANT THROUGHOUT ANALYSES	Income Level Farm Population Elderly Population Pediatric Population Spanish-American Popul. Education Level	Length of Stay Surgical Concentration Basic Service Mix Middle-Aged Caseload Pediatric Caseload Emergency/Outpat. Involv.

6

Actual/Expected Cost Comparisons for Group I Hospitals

This chapter discusses one of the two comparison techniques applied to Group I hospitals -- the actual/expected method. Both this technique and the actual/peer group approach, described in the next chapter, are based directly on the final total cost equation for Group I hospitals, which is discussed in Chapter 3. The next part of this chapter describes the methodology used to implement this technique, and the final section presents the results of this comparison method.

Methodology

The key element in this technique is the expected total cost of the individual hospital, i.e., the total cost that would be expected for the hospital given its values for the six cost determinants. This statistic is calculated in three steps. The first is to place the hospital's values for the six cost determinants in the final cost equation; the second is to multiply those values by the corresponding regression coefficients to obtain the cost contributions of the determinants; and the third is to sum the cost contributions and to add to that sum the constant term.[1]

In this comparison technique expected total cost is used directly. It is compared to the actual total cost of each hospital. To effect this comparison, both the dollar and percentage differences between the two costs are calculated.

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[1] For example, if a hospital has a length of stay of seven days, its value for this variable (i.e., 7) would be multiplied by the regression coefficient for length of stay (103.5) to obtain the cost contribution of length of stay for this hospital (7 x 103.5 = $724.50). The same procedure would then be followed for the other five cost determinants in order to obtain the cost contribution of each determinant for this hospital. These cost contributions are then added to the constant term (which is negative in this instance) in order to determine this hospital's expected cost.

Cost Comparisons

Table 6-1 shows the results of this comparison technique. The difference in dollars between actual cost and expected cost is calculated by subtracting the latter from the former. Consequently, a positive dollar difference means that a hospital's actual cost is larger than its expected cost, i.e., its actual cost is higher than expected given its values for the six cost determinants. A negative dollar difference indicates the reverse, i.e., the hospital's actual cost is lower than expected based on its values for the cost determinants.

Table 6-1 also shows the percentage difference between actual and expected costs. This statistic is calculated by dividing the dollar difference by expected cost (and expressing the result as a percentage). It thus indicates the percentage deviation from expected cost.

Both dollar and percentage differences are important. If the primary concern is to restrain hospital costs in Colorado, paramount attention should be given to dollar differences. If the main emphasis is upon evaluating the relative cost performance of individual hospitals, primary consideration should be accorded percentage differences. In most applications it is appropriate to consider both statistics.

Table 6-2 summarizes the dollar differences between actual and expected costs. As shown there, 26 hospitals exhibit positive dollar differences and 24 have negative dollar differences. This approximately even division is consistent with regression methodology and with other project results.

The dollar difference for 21 hospitals is less than ±$50. Another 12 institutions exhibit a dollar difference greater than ±$50, but less than ±$100. The actual costs of approximately two thirds of Group I hospitals are thus within ±$100 of their expected costs.

Six hospitals have actual costs $101 to $150 below their expected costs. Three hospitals show actual costs more than $150 below their expected costs. The maximum negative dollar difference is -$160 for Hospital (49).[2] In contrast, four hospitals exhibit actual costs $101 to $150 higher than their expected costs. Another four hospitals have actual costs more than $150 higher than their expected costs. The degree of positive deviation is high for three of these four institutions. The dollar difference is $300 for Hospital (29), $303 for Hospital (06), and $453 for Hospital (03).

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[2] As indicated in the Preface, in this and the subsequent three chapters hospitals are identified by number, rather than by name.

Table 6-1

COMPARISON OF ACTUAL AND EXPECTED COSTS

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
01	$ 821	$ 762	$ 59	7.7%
02	866	785	81	10.3
03*	2200	1747	453	25.9
04	1811	1849	-38	-2.1
05	585	556	29	5.2
06	1192	889	303	34.1
07	1196	1209	-13	-1.1
08	772	792	-20	-2.5
09*	1174	1114	60	5.4
10	653	780	-127	-16.3
11	504	438	66	15.1
12	541	513	28	5.5
13	1067	1070	-3	-0.3
14	724	880	-156	-17.7
15	796	819	-23	-2.8
16	724	668	56	8.4
17	631	658	-27	-4.1
18	834	835	-1	-0.1
19	576	571	5	0.9
20	1122	1090	32	2.9
21	628	679	-51	-7.5
22	776	794	-18	-2.3
23	630	707	-77	-10.9
24	667	790	-123	-15.6
25	472	597	-125	-20.9
26	670	499	171	34.3
27	630	703	-73	-10.4
28	874	819	55	6.7
29*	990	690	300	43.5
30	1051	1050	1	0.1

Table 6-1 (continued)

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
31	637	634	3	0.5
32	480	433	47	10.9
33	855	875	-20	-2.3
34	641	780	-139	-17.8
35	806	673	133	19.8
36	1457	1311	146	11.1
37	453	426	27	6.3
38	533	686	-153	-22.3
39	627	545	82	15.0
40	518	421	97	23.0
41	1001	854	147	17.2
42	632	599	33	5.5
43	1526	1519	7	0.5
44	1038	1067	-29	-2.7
45	765	803	-38	-4.7
46	681	817	-136	-16.6
47	575	686	-111	-16.2
48	1364	1244	120	9.6
49	556	716	-160	-22.3
50	665	735	-70	-9.5

* The three hospitals excluded from the cost analyses but included in the cost comparisons are Hospitals (03), (09), and (29). Values for the six cost determinants for Hospitals (03) and (09) were derived from actual data. In slight contrast, values for five cost determinants for Hospital (29) were calculated from actual data, while the value for the sixth determinant for this hospital was estimated based on inputs from several sources. While this estimate may not be precisely accurate, it is highly unlikely that it is sufficiently erroneous to appreciably affect the cost comparison results.

Table 6-2

SUMMARY OF DOLLAR DIFFERENCES

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
$0 - $50 Below Expected Cost		$1 - $50 Above Expected Cost	
Hospital	Amount	Hospital	Amount
18	-$1	30	$1
13	-$3	31	$3
07	-$13	19	$5
22	-$18	43	$7
33	-$20	37	$27
08	-$20	12	$28
15	-$23	05	$29
17	-$27	20	$32
44	-$29	42	$33
45	-$38	32	$47
04	-$38		
$51 - $100 Below Expected Cost		$51 - $100 Above Expected Cost	
21	-$51	28	$55
50	-$70	16	$56
27	-$73	01	$59
23	-$77	09	$60
		11	$66
		02	$81
		39	$82
		40	$97
$101 - $150 Below Expected Cost		$101 - $150 Above Expected Cost	
47	-$111	48	$120
24	-$123	35	$133
25	-$125	36	$146
10	-$127	41	$147
46	-$136		
34	-$139		
> $150 Below Expected Cost		> $150 Above Expected Cost	
38	-$153	26	$171
14	-$156	29	$300
49	-$160	06	$303
		03	$453

Table 6-3, analogous to Table 6-2, presents the percentage cost differences between actual and expected costs. Twenty-nine institutions, or almost 60% of Group I hospitals, have actual costs within 10% of their expected costs. The actual costs of seven hospitals are 11% to 20% below their expected costs. Three hospitals have actual costs more than 20% below their expected costs, but the margin is slim in each instance. The maximum negative percentage deviation is -22%, for both Hospitals (38) and (49).

Six hospitals have actual costs 11% to 20% higher than their expected costs. Five have actual costs more than 20% higher than their expected costs. The degree of deviation is large for

most of these institutions. The percentage difference for Hospital (40) is the lowest among this group of five, but at 23% it is still higher than the maximum negative percentage difference. The percentage difference for Hospital (03) is similar, 26%, but the percentage differences for the other three hospitals are significantly higher, equalling 34% for Hospitals (06) and (26), and 43% for Hospital (29).

Table 6-3

SUMMARY OF PERCENTAGE DIFFERENCES

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
0% - 5% Below Expected Cost		1% - 5% Above Expected Cost	
Hospital	Amount	Hospital	Amount
13	0%	19	1%
18	0%	20	3%
30	0%	05	5%
31	0%	09	5%
43	0%	12	5%
07	-1%		
04	-2%		
33	-2%		
22	-2%		
08	-3%		
44	-3%		
15	-3%		
17	-4%		
45	-5%		
6% - 10% Below Expected Cost		6% - 10% Above Expected Cost	
21	-8%	37	6%
27	-10%	42	6%
50	-10%	28	7%
		01	8%
		16	8%
		02	10%
		48	10%
11% - 15% Below Expected Cost		11% - 15% Above Expected Cost	
23	-11%	32	11%
		36	11%
		11	15%
		39	15%
16% - 20% Below Expected Cost		16% - 20% Above Expected Cost	
10	-16%	41	17%
24	-16%	35	20%
47	-16%		
46	-17%		
14	-18%		
34	-18%		
> 20% Below Expected Cost		> 20% Above Expected Cost	
25	-21%	40	23%
38	-22%	03	26%
49	-22%	06	34%
		26	34%
		29	43%

Thus, the majority of Group I hospitals have actual costs similar to their expected costs. However, there are other Group I institutions whose actual costs differ substantially from their expected costs. While approximately half of these hospitals exhibit a cost performance better than expected, the positive outliers are more striking than the negative outliers. The actual costs of three hospitals exceed their expected costs by at least $300. Correspondingly, four hospitals have actual costs more than 25% higher than their expected costs.

7

Actual/Peer Group Cost Comparisons for Group I Hospitals

This chapter discusses the second hospital cost comparison method -- the actual/peer group approach. This technique has two steps. The first is the construction of a peer group for each hospital. The second is the comparison of each hospital's actual cost with the average actual cost of the hospitals in its peer group.

Two premises form the basis for peer group construction. One is that a unique hospital peer group should be constructed for each hospital. This approach differs sharply from the customary practice of employing fixed hospital peer groups for cost comparison purposes.[1] Under the fixed peer group approach, the 50 Group I hospitals might, as an example, be divided into six groups of approximately eight hospitals each. Under the approach used in this study, there will be 50 unique peer groups (unless the peer groups of two or more hospitals are precisely duplicative), i.e., one peer group for each hospital. The paramount advantage of the latter approach is that each hospital is near the middle of its peer group. No hospital is an outlier within its own peer group.

The second premise is that the parameters for grouping hospitals should not be chosen arbitrarily. Instead, they should be those factors which have the strongest impact on Group I hospital costs, i.e., the six final cost determinants. The strength of this approach speaks for itself. Grouping hospitals in terms of factors unrelated to cost is both ineffective from the perspective of constraining hospital costs and inequitable from the viewpoint of individual hospitals. The approach taken in this project has the reverse implications.

The next section of this chapter describes the methodology employed to implement this comparison technique, concentrating on the techniques used to construct the peer groups. The subsequent two sections discuss respectively the composition of the peer groups and the actual/peer group cost comparisons. The final portion of this chapter discusses the similarity between the findings of the two cost comparison techniques.

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[1] For example, the limitation on hospital inpatient general routine service costs imposed by the Medicare program is based on the use of fixed peer groups which reflect only three factors -- income level, bed size, and metropolitan/nonmetropolitan location.

Methodology

Four conditions were used to construct the hospital peer groups. The first condition is that the average of the expected costs of the peer group members must be within 3% of the expected cost of the primary hospital (the hospital for which the peer group is being constructed).[2] This condition has two important implications. First, its satisfaction ensures that the peer group members, in aggregate, are highly similar to the primary hospital in terms of the net impact of the six cost determinants. Second, restricting the permissible deviation to the narrow interval of 3% assures that the degree of built-in bias in this cost comparison technique is minor. That is, no hospital is inequitably treated by being assigned a peer group whose average expected cost is appreciably different from its own.

The second condition is that each peer group should have four to six members. If a peer group includes less than four hospitals, there is a sizeable risk that the average actual cost of the peer group (i.e., the standard of comparison in this technique) will be substantially influenced by peer group members which are outliers in terms of actual costs (i.e., whose actual costs vary substantially from their expected costs). That is, as the size of the peer group shrinks, its average actual cost becomes progressively more affected by the actual cost of each group member. A minimum of four hospitals for each peer group was thus established.

Conversely, as the size of the peer group increases beyond six, the impact of each member on the group's average actual cost changes only modestly with the addition of new hospitals. Hence, to restrict the peer groups to a manageable size, a maximum of six hospitals for each peer group was adopted.

The third condition is that the expected cost of each peer group member must be within 10% of the expected cost of the primary hospital. The purpose of this condition is to ensure that in terms of the net impact of the six cost determinants, no peer group member is substantially different from the primary hospital.

The fourth condition is that the value of each cost determinant for each peer group member must be within two standard deviations of the value of the corresponding cost determinant for the primary hospital.[3]

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[2] The calculation of a hospital's expected cost is described in the preceding chapter.

[3] The standard deviation is a classic measure of dispersion. In a normal distribution, 95% of the observations lie within two standard deviations from the mean. Although not all the cost determinants are normally distributed, the two standard deviation rule was selected for the fourth condition since its satisfaction makes it likely that the primary hospital is not grossly dissimilar from any member of its peer group in terms of the cost determinants.

To illustrate the operation of this condition, suppose the primary hospital has a length of stay of 7.00 days. The standard deviation for this variable is 1.14. Therefore, to be eligible for this primary hospital's peer group, other hospitals must have a length of stay between 7.00 ± 2.28, or 4.72 to 9.28. The same technique is applied to the other five cost determinants in order to construct acceptable ranges for each determinant for the hospital.

The fourth condition increases the likelihood that the peer group will remain stable over time, i.e., that it will continue to represent a suitable standard for comparing the cost of the primary hospital. This condition is necessary because it is possible that two hospitals will have similar expected costs at a point in time, but dissimilar costs in the future due to domination by different cost determinants.

For example, consider two hospitals which at present have similar expected costs. Suppose that the expected cost of one hospital is dominated by its extensive involvement in long-term care and that the expected cost of the other hospital is strongly impacted by its involvement in medical education. These two hospitals might continue to have similar expected costs over time, but there is a significant possibility that they may not. That is, the costs associated with long-term care involvement may rise faster or slower than the costs associated with medical education involvement.

It was anticipated that all four conditions might not be satisfied in the construction of a peer group for each hospital. To accommodate this possibility, a four-tier peer group classification system was developed. The first and highest tier is composed of those peer groups which satisfy all four conditions. Such groups are termed fully satisfactory.

The second tier includes those peer groups which do not meet all four conditions, but which satisfy in aggregate the thrust of these conditions. Peer groups coming within the second tier are termed largely satisfactory. All groups considered largely satisfactory must satisfy the first condition, and must meet one of two additional standards. One is that the peer group may have only three members provided that it satisfies the third and fourth conditions. This type of largely satisfactory peer group is thus smaller than any fully satisfactory group, but each member is similar to the primary hospital just as each member of a fully satisfactory group is similar to the primary hospital.

The alternative standard is that if the group has at least four members, the third and/or fourth conditions can be broken. To meet this standard the fourth condition must be either satisfied or only narrowly violated by each peer group member; the third condition cannot be violated by a large margin by any peer group member; and the aggregate extent to which these two conditions are violated by

all peer group members must be low compared to the degree of aggregate satisfaction. In constructing groups of this type, preference was given to larger groups, because the larger the group, the less sensitive is its average actual cost to the actual cost of any member hospital.

The third tier of the classification system is comprised of those groups for which there are substantial violations, but which in aggregate appear to represent the characteristics of the primary hospital in terms of the cost determinants. Groups of this type, termed minimally satisfactory, must satisfy both the first and second conditions. However, substantial violation of the third and/or fourth conditions is permitted as long as the degree of violation by any single group member is not egregious and the extent of aggregate violation is not sufficiently high to suggest that the integrity of the group has been undermined.

The fourth tier of the classification system describes those situations in which it is impossible to construct a peer group which meets even the relatively lax standards of the minimally satisfactory tier. In instances of this type no peer group was constructed, and the primary hospital was necessarily placed in the unsatisfactory peer group category.

The second step in the actual/peer group technique entails the comparison of each primary hospital's actual cost with the average actual cost of its peer group members. As in the actual/expected technique, both dollar and percentage differences between these costs are calculated in order to carry out this comparison.

Composition of the Peer Groups

The composition of the peer groups is specified in Table 7-1, which is organized in terms of the four tiers described earlier. Twenty-six hospitals have fully satisfactory peer groups; 16 have largely satisfactory peer groups; four have minimally satisfactory peer groups; and four have unsatisfactory peer groups (i.e., no peer group).

Although there are no identical peer groups, Hospitals (11), (32), (37), and (40) form a mutually exclusive peer group. That is, each of these hospitals has the other three hospitals as the members of its peer group. This is the only instance in which a fixed peer group would be as satisfactory for Group I hospitals as the unique peer groups -- a finding which supports the use of the latter approach for these hospitals.

As expected, there are other commonalities in the peer groups. For example, the peer groups of Hospitals (02) and (10) have five common members and each other. The same is true for Hospitals (16) and (21). Hospitals (05) and (39) have four common members and each other in

Table 7-1

COMPOSITION OF PEER GROUPS

FULLY SATISFACTORY GROUPS

Primary Hospital	Peer Group Hospitals
01	02 24 10 34 23 50
02	01 22 08 24 10 34
05	12 39 19 42 25
08	01 24 02 34 10 45
10	01 22 02 24 08 34
15	02 24 18 41 22 45
16	21 35 27 38 31 47
18	02 33 14 41 15 45
21	16 35 27 38 31 47
22	02 24 10 34 15 45
23	01 47 21 49 38 50
24	02 22 08 34 10 45
27	16 47 21 49 23 50
28	06 24 08 33 10 41
31	16 38 19 21
33	06 41 15 18
34	01 22 02 24 10 45
35	16 31 23 47 27 49
38	16 27 21 31 23 50
39	05 25 12 26 19 42
41	06 22 15 33 18 45
42	05 25 17 39 19
45	02 22 15 24 18 34
47	16 27 21 35 23 49
49	01 23 16 27 21 50
50	01 27 10 38 23 49

Table 7-1 (continued)

LARGELY SATISFACTORY GROUPS

Primary Hospital	Peer Group Hospitals
06	14 30 15 33 18 41
07	09 36 13 43 30
09	06 30 07 36 13 44
11	32 37 40
12	05 26 11 39 19

Primary Hospital	Peer Group Hospitals
13	06 30 07 44 09
14	06 30 18 41 22 45
17	25 47 35 42
19	05 42 25 39
25	05 35 17 39 19 42
26	05 32 12 37 19 39

Primary Hospital	Peer Group Hospitals
30	06 13 07 14 09 44
32	11 37 40
37	11 32 40
40	11 32 37
44	06 13 07 30 09

MINIMALLY SATISFACTORY GROUPS

36	04 13 07 30 09 43

43	03 36 04 07

46	02 33 08 35 20 50
48	07 43 09 44 36

HOSPITALS WITH UNSATISFACTORY GROUPS

(03), (04), (20), (29)

their peer groups. As another example, Hospitals (02), (10), (24), and (34) have at least the other three hospitals in their peer groups. So do Hospitals (07), (09), (13), and (30). In addition, Hospitals (38), (47), and (49) have four common members in their peer groups, as do Hospitals (01), (08), and (22).

Thirty hospitals, or almost two thirds of the group, have six institutions in their peer groups. Seven hospitals have five-member peer groups; five hospitals have four-member peer groups; and four hospitals have three-member peer groups. The latter institutions are those described above -- Hospitals (11), (32), (37), and (40).

The 46 peer groups together contain 247 hospitals. Hence, on average, a hospital is a member of five peer groups. However, four institutions are not members of any peer group -- Hospitals (28), (29), (46), and (48). Hospitals (03) and (20) are members of a single peer group; and Hospitals (04), (17), and (26) only belong to two peer groups. At the opposite end of the distribution, Hospital (02) is included in ten peer groups, and Hospital (24) is present in nine peer groups. Four institutions [Hospitals (06), (10), (22), and (45)] are members of eight peer groups.

Cost Comparisons

Table 7-2 contains the results of the cost comparisons using the actual/peer group technique. Analogous to Table 6-1, both the dollar and percentage differences for each hospital are shown. In this technique the standard of comparison is the average actual cost of the peer group. Hence, the dollar difference is calculated by subtracting from each hospital's actual cost the average actual cost of its peer group members. The percentage difference equals the dollar difference divided by the average actual cost of the peer group (and expressed as a percentage). For both statistics a positive value indicates that a hospital's cost performance is less favorable than that of its peers; a negative value has the reverse significance.

Table 7-2 also indicates the type of each hospital's peer group. This is important since the higher the tier of the peer group, the greater the confidence that can be placed in the findings of the cost comparisons. Greatest reliance can thus be placed on the cost comparisons in which the peer group is fully satisfactory. Almost as much confidence can be given to those cost comparisons involving a largely satisfactory peer group. More caution should be invoked in using the results for those hospitals which have minimally satisfactory peer groups. This comparison technique is naturally not appropriate at this time for those four hospitals which are in the unsatisfactory peer group category.

Table 7-2

COMPARISON OF ACTUAL AND PEER GROUP COSTS

Hospital	Type of Peer Group*	Actual Cost	Mean Actual Cost of Peer Group	Dollar Difference	Percentage Difference
01	FS	$ 821	$ 687	$ 134	19.5%
02	FS	866	722	144	19.9
03**	U	2200	-	-	-
04	U	1811	-	-	-
05	FS	585	570	15	2.6
06	LS	1192	877	315	35.9
07	LS	1196	1255	-59	-4.7
08	FS	772	736	36	4.9
09**	LS	1174	1167	7	0.6
10	FS	653	757	-104	-13.7
11	LS	504	484	20	4.1
12	LS	541	592	-51	-8.6
13	LS	1067	1130	-63	-5.6
14	LS	724	937	-213	-22.7
15	FS	796	818	-22	-2.7
16	FS	724	635	89	14.0
17	LS	631	621	10	1.6
18	FS	834	835	-1	-0.1
19	LS	576	579	-3	-0.5
20	U	1122	-	-	-
21	FS	628	651	-23	-3.5
22	FS	776	731	45	6.2
23	FS	630	630	0	0.0
24	FS	667	746	-79	-10.6
25	LS	472	643	-171	-26.6
26	LS	670	544	126	23.2
27	FS	630	630	0	0.0
28	FS	874	857	17	2.0

Table 7-2 (continued)

Hospital	Type of Peer Group*	Actual Cost	Mean Actual Cost of Peer Group	Dollar Difference	Percentage Difference
29**	U	990	-	-	-
30	LS	1051	1065	-14	-1.3
31	FS	637	615	22	3.6
32	LS	480	492	-12	-2.4
33	FS	855	956	-101	-10.6
34	FS	641	758	-117	-15.4
35	FS	806	625	181	29.0
36	MS	1457	1304	153	11.7
37	LS	453	501	-48	-9.6
38	FS	533	652	-119	-18.3
39	FS	627	579	48	8.3
40	LS	518	479	39	8.1
41	FS	1001	870	131	15.1
42	FS	632	578	54	9.3
43	MS	1526	1666	-140	-8.4
44	LS	1038	1136	-98	-8.6
45	FS	765	763	2	0.3
46	MS	681	848	-167	-19.7
47	FS	575	662	-87	-13.1
48	MS	1364	1278	86	6.7
49	FS	556	683	-127	-18.6
50	FS	665	637	28	4.4

* Under this heading, FS indicates a fully satisfactory group; LS a largely satisfactory group; MS a minimally satisfactory group; and U an unsatisfactory group.

** These three hospitals are the institutions discussed earlier, which are included in the cost comparisons, but are excluded from the cost analyses.

Table 7-3 summarizes the dollar difference results. Twenty-one of the 46 hospitals exhibit dollar differences smaller than ± $50. Another nine hospitals have dollar differences greater than ± $50, but smaller than ± $100. Thus, analogous to the actual/expected comparisons, approximately two thirds of the 46 hospitals have actual costs within $100 of their peer group means.

Table 7-3

SUMMARY OF DOLLAR DIFFERENCES

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
$0 - $50 Below Peer Group Mean		$1 - $50 Above Peer Group Mean	
Hospital	Amount	Hospital	Amount
23	$0	45	$2
27	$0	09	$7
18	-$1	17	$10
19	-$3	05	$15
32	-$12	28	$17
30	-$14	11	$20
15	-$22	31	$22
21	-$23	50	$28
37	-$48	08	$36
		40	$39
		22	$45
		39	$48
$51 - $100 Below Peer Group Mean		$51 - $100 Above Peer Group Mean	
12	-$51	42	$54
07	-$59	48	$86
13	-$63	16	$89
24	-$79		
47	-$87		
44	-$98		
$101 - $150 Below Peer Group Mean		$101 - $150 Above Peer Group Mean	
33	-$101	26	$126
10	-$104	41	$131
34	-$117	01	$134
38	-$119	02	$144
49	-$127		
43	-$140		
> $150 Below Peer Group Mean		> $150 Above Peer Group Mean	
46	-$167	36	$153
25	-$171	35	$181
14	-$213	06	$315

There are nine hospitals whose cost performances are substantially more favorable than their peer group means. Six of these hospitals have actual costs $101 to $150 below their means, and the other three hospitals exhibit costs more than $150 below their means. At the opposite end of the spectrum, there are four hospitals whose actual costs exceed their peer group means by $101 to $150. Another three

hospitals exhibit actual costs more than $150 above their means. There are fewer positive outliers in this cost comparison than in the actual/expected comparison, since two of the three hospitals with the largest positive dollar differences in the latter comparison [Hospitals (03) and (29)] have unsatisfactory peer groups and are thus not included in these comparisons.

Table 7-4 summarizes the percentage cost differences. As in the actual/expected comparisons, approximately 60% of the hospitals have actual costs which differ from their peer group means by less than 10%. Three hospitals have actual costs more than 20% higher than their peer group means, and two institutions have actual costs more than 20% below their peer group means.

Table 7-4

SUMMARY OF PERCENTAGE DIFFERENCES

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
0% - 5% Below Peer Group Mean		1% - 5% Above Peer Group Mean	
Hospital	Amount	Hospital	Amount
27	0%	09	1%
45	0%	17	2%
23	0%	28	2%
18	0%	05	3%
19	-1%	11	4%
30	-1%	31	4%
32	-2%	50	4%
15	-3%	08	5%
21	-4%		
07	-5%		
6% - 10% Below Peer Group Mean		6% - 10% Above Peer Group Mean	
13	-6%	22	6%
43	-8%	48	7%
44	-9%	40	8%
12	-9%	39	8%
37	-10%	42	9%
11% - 15% Below Peer Group Mean		11% - 15% Above Peer Group Mean	
24	-11%	36	12%
33	-11%	16	14%
47	-13%	41	15%
10	-14%		
34	-15%		
16% - 20% Below Peer Group Mean		16% - 20% Above Peer Group Mean	
38	-18%	01	20%
49	-19%	02	20%
46	-20%		
> 20% Below Peer Group Mean		> 20% Above Peer Group Mean	
14	-23%	26	23%
25	-27%	35	29%
		06	36%

Similarity of the Comparison Results

The correlation between the actual/expected dollar difference and the actual/peer group dollar difference is .86. The extent of common variation between these statistics is thus 74%.[4] The results are similar for the percentage differences obtained through the two techniques. The correlation between these two statistics is .84, so that the degree of common variation between them is 71%.

Two conclusions emerge from these results. First, there is strong convergence between the findings of the two techniques. Second, there is sufficient divergence between their results to permit such results to be substantially different for individual hospitals.

A further correlation analysis indicates that the divergence between the techniques is no higher for those hospitals with largely satisfactory peer groups than for those institutions with fully satisfactory peer groups. An additional analysis shows that the divergence between the techniques is not produced by those hospitals with minimally satisfactory peer groups. These findings both support the integrity of the largely and minimally satisfactory peer groups and indicate that other factors are responsible for the divergence between the two techniques.[5]

Table 7-5 compares the results of the two techniques for each hospital. It indicates the divergence between the actual/expected dollar difference and the actual/peer group dollar difference. This statistic is calculated as the latter minus the former, and is termed the dollar divergence. If this statistic is positive, the actual/peer group comparison is less favorable to the hospital than the actual/expected comparison. The converse holds if it is negative.

The dollar divergence findings illustrate both conclusions drawn above about the comparability of the two techniques. On the one hand, there is evidence of the convergence of the two techniques. The average dollar divergence is -$4, a trivial sum compared to hospital costs. Moreover, there are several hospitals whose dollar divergence is very low. It equals zero for Hospital (18), $1 for Hospital (15), -$8 for Hospital (19), and $8 for Hospital (36). On the other hand, there is evidence of the divergence between these two techniques. Seventeen hospitals, or approximately 40% of the total, exhibit a dollar divergence exceeding ±$50. One of these institutions -- Hospital (43), with a minimally satisfactory peer group -- has a dollar divergence of -$146.

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[4] The extent of common variation between two statistics or factors is obtained by squaring their correlation. It can be interpreted as indicating the degree to which the two factors vary together.

[5] Chapter 10 points up several of these factors.

Table 7-5 also shows for each hospital its percentage divergence, which equals its dollar divergence divided by its expected cost (and expressed as a percentage). This statistic is equivalent to the percentage difference between the comparison standards in the two techniques -- expected cost and average actual cost of the peer group. The sign of the percentage divergence has the same implications as that of the dollar divergence.

The percentage divergence is no higher than ±5% for 23 hospitals, or one half of the total group. For these hospitals divergence between the two techniques is minor. However, the percentage divergence is greater than ±5%, but less than ±10%, for 15 hospitals, or almost one third of the group. For these hospitals, the extent of divergence may be sufficient to affect the conclusions drawn from the cost comparisons, at least to some extent.

For the remaining eight hospitals, or almost 20% of the group, the percentage divergence is higher than ±10%. For these hospitals, the divergence between the results of the two techniques is in all likelihood sufficient to alter the conclusions drawn from the cost comparisons. For example, if a hospital's percentage difference is 10% in the actual/expected comparisons, then a percentage divergence of ±10% means that its percentage difference in the actual/peer group comparison approximates 20% or 0%. Either of these findings has distinctly different implications than the result of the actual/expected comparisons.

There are thus strong commonalities between the results of the two techniques, and there are important differences. These results are not unexpected and, at a minimum, show that the two techniques are not precisely duplicative. This being the case, it is essential to consider their strengths and weaknesses and to discuss possible synergisms between them. These two topics are among the subjects addressed in Chapter 10.

Table 7-5

COMPARISON OF THE RESULTS OF THE TWO TECHNIQUES

Hospital	Type of Peer Group	Actual/ Expected Dollar Difference	Actual/ Peer Group Dollar Difference	Dollar Divergence	Percentage Divergence
01	FS	$ 59	$ 134	$ 75	9.8%
02	FS	81	144	63	8.0
03	U	453	-	-	-
04	U	-38	-	-	-
05	FS	28	15	-13	-2.3
06	LS	303	315	12	1.3
07	LS	-13	-59	-46	-3.8
08	FS	-20	36	56	7.1
09	LS	60	7	-53	-4.8
10	FS	-127	-104	23	2.9
11	LS	66	20	-46	-10.5
12	LS	28	-51	-79	-15.4
13	LS	-3	-63	-60	-5.6
14	LS	-156	-213	-57	-6.5
15	FS	-23	-22	1	0.1
16	FS	56	89	33	4.9
17	LS	-27	10	37	5.6
18	FS	-1	-1	0	0.0
19	LS	5	-3	-8	-1.4
20	U	32	-	-	-
21	FS	-51	-23	28	4.1
22	FS	-18	45	63	7.9
23	FS	-77	0	77	10.9
24	FS	-123	-79	44	5.6
25	LS	-125	-171	-46	-7.7

Table 7-5 (continued)

Hospital	Type of Peer Group	Actual/ Expected Dollar Difference	Actual/ Peer Group Dollar Difference	Dollar Divergence	Percentage Divergence
26	LS	$ 171	$ 126	$ -45	-9.0%
27	FS	-74	0	74	10.5
28	FS	55	17	-38	-4.6
29	U	300	-	-	-
30	LS	1	-14	-15	-1.4
31	FS	3	22	19	3.0
32	LS	47	-12	-59	-13.6
33	FS	-20	-101	-81	-9.3
34	FS	-138	-117	21	2.7
35	FS	133	181	48	7.1
36	MS	145	153	8	0.6
37	LS	27	-48	-75	-17.6
38	FS	-153	-119	34	5.0
39	FS	82	48	-34	-6.2
40	LS	97	39	-58	-13.8
41	FS	147	131	-16	-1.9
42	FS	33	54	21	3.5
43	MS	6	-140	-146	-9.6
44	LS	-29	-98	-69	-6.5
45	FS	-38	2	40	5.0
46	MS	-136	-167	-31	-3.8
47	FS	-111	-87	24	3.5
48	MS	120	86	-34	-2.7
49	FS	-159	-127	32	4.5
50	FS	-70	28	98	13.3

8

Departmental Cost Comparisons for Group I Hospitals

The departmental cost comparisons are based on the final departmental cost equations (discussed in Chapter 4) just as the total cost comparisons are based on the final total cost equation. The departmental cost comparisons employ only the actual/expected approach, since it seemed unnecessary and perhaps confusing at this stage to create a separate peer group for each hospital for each departmental cost.[1]

The methodology used in this chapter is analogous to the actual/expected technique employed in Chapter 6. Hence, the dollar and percentage differences are defined in the same way for the departmental costs as for total cost. A positive or negative sign for these statistics has the same implications for a departmental cost as for total cost: a positive value means that a hospital's cost performance is less favorable than expected, and a negative value denotes the reverse.

In this chapter the findings of the five departmental cost comparisons are discussed sequentially. The next topic addressed is the relationship between the total and departmental cost comparisons. The last chapter section serves as a reference by presenting the complete departmental cost comparison tables.

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[1] As pointed out in Chapter 10, departmental peer groups can be constructed using the same techniques as were employed for the development of peer groups for the entire hospital. In the future it could be desirable to create such peer groups.

Nursing Cost Comparisons

As shown in Table 8-1, 32 hospitals, or more than 60% of the total group, exhibit nursing costs within $25 of their expected values. Only two have nursing costs more than $50 lower than their expected values [Hospitals (27) and (49)]. However, five hospitals show nursing costs more than $50 higher than their expected values. The difference is especially great for Hospitals (03) and (29): the dollar difference for the former is $228 and for the latter, $116.

Table 8-1

SUMMARY OF DOLLAR DIFFERENCES FOR NURSING COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
$0 - $25 Below Expected Cost		$1 - $25 Above Expected Cost	
Hospital	Amount	Hospital	Amount
30	-$2	12	$1
05	-$3	28	$2
20	-$3	08	$3
15	-$4	44	$3
34	-$7	21	$5
45	-$10	02	$7
17	-$11	11	$7
18	-$11	37	$7
25	-$12	19	$8
47	-$12	31	$8
33	-$13	22	$10
13	-$21	07	$15
50	-$22	06	$17
23	-$24	43	$18
24	-$24	16	$19
		39	$25
		41	$25
$26 - $50 Below Expected Cost		$26 - $50 Above Expected Cost	
04	-$27	01	$29
42	-$27	35	$29
14	-$30	26	$36
38	-$30	36	$41
46	-$46	32	$46
10	-$49		
$51 - $75 Below Expected Cost		$51 - $75 Above Expected Cost	
27	-$52	09	$54
49	-$62	40	$54
> $75 Below Expected Cost		> $75 Above Expected Cost	
(none)		48	$86
		29	$116
		03	$228

Table 8-2 shows that 29 hospitals, or almost 60% of the total group, have nursing costs within 10% of their expected values. Four hospitals exhibit nursing costs more than 20% below their expected values. The negative deviation is strongest for Hospitals (49) and (27) -- the same institutions which have negative dollar differences greater than -$50.

Six hospitals have nursing costs more than 20% higher than their expected values. For Hospitals (48) and (26), the positive deviation is substantial, but relatively modest (23% and 28% respectively). The percentage difference is much larger for the other four hospitals. It equals 41% for Hospital (03) and 45% for Hospital (32). It exceeds 50% for Hospitals (40) and (29), equalling 55% for the former and 64% for the latter.

Table 8-2

SUMMARY OF PERCENTAGE DIFFERENCES FOR NURSING COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
0% - 5% Below Expected Cost		1% - 5% Above Expected Cost	
Hospital	Amount	Hospital	Amount
20	-1%	08	1%
30	-1%	12	1%
05	-2%	28	1%
15	-2%	44	1%
34	-3%	02	3%
04	-5%	21	3%
18	-5%	07	4%
33	-5%	43	4%
45	-5%	19	5%
		22	5%
		31	5%
6% - 10% Below Expected Cost		6% - 10% Above Expected Cost	
17	-6%	06	7%
47	-6%	11	7%
13	-7%	37	7%
25	-7%	36	10%
		41	10%
11% - 15% Below Expected Cost		11% - 15% Above Expected Cost	
24	-11%	16	11%
50	-11%	01	14%
14	-12%		
23	-12%		
16% - 20% Below Expected Cost		16% - 20% Above Expected Cost	
38	-16%	09	16%
42	-17%	35	16%
		39	18%
> 20% Below Expected Cost		> 20% Above Expected Cost	
46	-21%	48	23%
10	-22%	26	28%
27	-27%	03	41%
49	-31%	32	45%
		40	55%
		29	64%

Ancillary Cost Comparisons

Twenty-two hospitals, or less than one half of the total group, have ancillary costs within $25 of their expected values, as shown in Table 8-3. Five hospitals have ancillary costs more than $50 below their expected values. The highest negative deviations are -$90 and -$75 for Hospitals (14) and (24) respectively. Eight hospitals have ancillary costs more than $50 above their expected values. Hospitals (06) and (29) stand out in this regard, with dollar differences of $167 and $117 respectively. The positive deviation is also substantial for Hospitals (11), (41), (48), and (36), with respective dollar differences of $85, $79, $73, and $71.

Table 8-3

SUMMARY OF DOLLAR DIFFERENCES FOR ANCILLARY COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
$0 - $25 Below Expected Cost		$1 - $25 Above Expected Cost	
Hospital	Amount	Hospital	Amount
28	$0	16	$6
37	-$2	22	$6
33	-$5	08	$7
32	-$6	40	$9
35	-$8	39	$10
19	-$13	46	$11
18	-$16	42	$12
13	-$17	07	$23
27	-$17	20	$25
15	-$19		
17	-$19		
21	-$21		
50	-$22		
$26 - $50 Below Expected Cost		$26 - $50 Above Expected Cost	
31	-$26	02	$28
23	-$30	04	$37
25	-$30	12	$38
38	-$31	09	$42
03	-$32	05	$45
44	-$33		
30	-$36		
10	-$41		
49	-$41		
45	-$49		
$51 - $75 Below Expected Cost		$51 - $75 Above Expected Cost	
47	-$61	26	$52
34	-$62	01	$55
43	-$62	36	$71
24	-$75	48	$73
> $75 Below Expected Cost		> $75 Above Expected Cost	
14	-$90	41	$79
		11	$85
		29	$117
		06	$167

In contrast to the nursing cost findings, only 21 hospitals, or almost 40% of the total group, exhibit ancillary costs within 10% of their expected values, as shown in Table 8-4. Seven hospitals have ancillary costs more than 20% lower than their expected values. Three are prominent in this regard -- Hospitals (47), (24), and (14). Their respective percentage differences are -35%, -33%, and -32%.

Nine hospitals have ancillary costs more than 20% greater than their expected values. The percentage difference is greater than 50% for two of these hospitals -- Hospitals (06) and (11) -- equalling 64% and 77% respectively. The positive deviation is also high for Hospitals (26) and (29), which have percentage differences of 40% and 47% respectively.

Table 8-4

SUMMARY OF PERCENTAGE DIFFERENCES FOR ANCILLARY COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
0% - 5% Below Expected Cost		1% - 5% Above Expected Cost	
Hospital	Amount	Hospital	Amount
28	0%	22	2%
33	-2%	16	3%
37	-2%	08	4%
13	-5%		
35	-5%		
6% - 10% Below Expected Cost		6% - 10% Above Expected Cost	
03	-6%	04	6%
18	-6%	07	6%
32	-6%	39	7%
15	-7%	46	7%
19	-9%	40	8%
27	-9%	42	8%
30	-10%		
11% - 15% Below Expected Cost		11% - 15% Above Expected Cost	
21	-11%	09	12%
44	-11%	02	13%
50	-11%	20	15%
17	-13%		
31	-13%		
43	-13%		
16% - 20% Below Expected Cost		16% - 20% Above Expected Cost	
23	-16%	36	17%
10	-16%		
38	-18%		
> 20% Below Expected Cost		> 20% Above Expected Cost	
45	-21%	01	25%
49	-21%	48	25%
25	-22%	12	28%
34	-25%	05	32%
14	-32%	41	32%
24	-33%	26	40%
47	-35%	29	47%
		06	64%
		11	77%

Hotel Cost Comparisons

Twenty-eight hospitals, or almost 60% of the total group, have hotel costs within $25 of their expected values, as displayed in Table 8-5. There are three hospitals whose hotel costs are more than $50 below their expected values. Similarly, there are three hospitals which exhibit hotel costs more than $50 above their expected values. There is a single distinct outlier in each direction. On the negative side, Hospital (04) has a hotel cost $105 lower than its expected value; on the positive side, Hospital (03) has a hotel cost $210 higher than its expected value.

In sharp distinction to the nursing cost findings, and in modest contrast to the ancillary cost results, only 17 hospitals, or about one third of the total group, have hotel costs within 10% of their expected values, as shown in Table 8-6. Only four hospitals have hotel costs more than 20% lower than their expected values. As with the dollar difference

Table 8-5

SUMMARY OF DOLLAR DIFFERENCES FOR HOTEL COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
$0 - $25 Below Expected Cost		$1 - $25 Above Expected Cost	
Hospital	Amount	Hospital	Amount
21	$0	20	$1
31	-$1	12	$2
05	-$4	18	$4
41	-$4	45	$6
11	-$8	09	$10
17	-$8	19	$12
33	-$12	40	$12
50	-$12	06	$13
15	-$14	13	$17
16	-$16	02	$19
47	-$21	37	$19
23	-$22	39	$20
22	-$23	44	$24
34	-$23		
46	-$23		
$26 - $50 Below Expected Cost		$26 - $50 Above Expected Cost	
10	-$26	28	$28
25	-$26	01	$32
27	-$26	30	$33
08	-$31	42	$34
14	-$37	26	$37
38	-$48	48	$37
		29	$38
		32	$38
		35	$41
		07	$46
$50 - $75 Below Expected Cost		$50 - $75 Above Expected Cost	
49	-$52	43	$63
24	-$53	36	$64
> $75 Below Expected Cost		> $75 Above Expected Cost	
04	-$105	03	$210

results, Hospital (04) stands out with a percentage difference of -53%. The negative deviation is also substantial (approximately -33%) for the other three institutions [Hospitals (24), (38), and (49)].

Ten hospitals, or one fifth of the total group, exhibit hotel costs more than 20% higher than their expected values. The sharp outlier is again Hospital (03), whose hotel cost is 117% higher than its expected value. Five hospitals have percentage differences between 30% and 40% -- Hospitals (32), (43), (26), (36), and (29). The other four institutions in this category show hotel costs less than 30% above their expected values.

Table 8-6

SUMMARY OF PERCENTAGE DIFFERENCES FOR HOTEL COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
0% - 5% Below Expected Cost		1% - 5% Above Expected Cost	
Hospital	Amount	Hospital	Amount
20	0%	12	2%
21	0%	18	2%
31	-1%	45	3%
41	-2%	09	5%
05	-3%		
17	-5%		
6% - 10% Below Expected Cost		6% - 10% Above Expected Cost	
11	-7%	06	7%
33	-7%	13	9%
50	-8%	19	10%
15	-9%		
11% - 15% Below Expected Cost		11% - 15% Above Expected Cost	
16	-11%	02	11%
47	-13%	44	11%
22	-14%	40	13%
23	-14%	48	14%
46	-14%		
16% - 20% Below Expected Cost		16% - 20% Above Expected Cost	
10	-16%	28	16%
34	-16%	39	17%
27	-17%	01	20%
08	-18%	14	20%
25	-18%	37	20%
> 20% Below Expected Cost		> 20% Above Expected Cost	
24	-33%	30	22%
49	-34%	07	24%
38	-35%	42	24%
04	-53%	35	26%
		29	32%
		36	32%
		26	34%
		43	36%
		32	39%
		03	117%

Administrative Cost Comparisons

Thirty-six institutions, or more than 70% of the total group, have administrative costs within $25 of their expected values, as displayed in Table 8-7. Only three have administrative costs more than $50 higher than their expected values -- Hospitals (06), (03), and (20). Their dollar differences are respectively $92, $84, and $51. Two hospitals have administrative costs more than $50 lower than their expected values -- Hospitals (07) and (46), which have dollar differences of -$72 and -$58 respectively.

Table 8-7

SUMMARY OF DOLLAR DIFFERENCES FOR ADMINISTRATIVE COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
$0 - $25 Below Expected Cost		$1 - $25 Above Expected Cost	
Hospital	Amount	Hospital	Amount
19	-$1	05	$4
12	-$2	14	$4
32	-$3	33	$4
24	-$4	18	$5
47	-$5	22	$5
40	-$6	02	$7
11	-$7	39	$10
21	-$10	13	$13
37	-$12	31	$14
44	-$13	45	$14
23	-$14	50	$14
10	-$16	43	$15
34	-$16	17	$16
42	-$18	08	$19
15	-$20	16	$19
01	-$21	30	$21
49	-$24	04	$22
		27	$22
		35	$24
$26 - $50 Below Expected Cost		$26 - $50 Above Expected Cost	
38	-$34	26	$26
09	-$36	41	$28
48	-$44	28	$34
36	-$45	29	$35
25	-$46		
$51 - $75 Below Expected Cost		$51 - $75 Above Expected Cost	
46	-$58	20	$51
07	-$72		
> $75 Below Expected Cost		> $75 Above Expected Cost	
(none)		03	$84
		06	$92

As indicated in Table 8-8, 20 hospitals, or 40% of the total group, have administrative costs within 10% of their expected values. In contrast to the hotel cost results, the number of hospitals exhibiting negative percentage differences greater than 20% is the same as the number showing positive percentage differences of at least that magnitude. Six institutions fall into the former category. The most prominent are Hospitals (25), (07), and (46), whose respective percentage differences are -40%, -35%, and -34%.

Another six hospitals have administrative costs more than 20% above their expected values. The outlier in this category is Hospital (06), whose administrative cost is 65% higher than its expected value. The next highest outlier is Hospital (29), which has administrative costs 37% higher than its expected value.

Table 8-8

SUMMARY OF PERCENTAGE DIFFERENCES FOR ADMINISTRATIVE COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
0% - 5% Below Expected Cost		1% - 5% Above Expected Cost	
Hospital	Amount	Hospital	Amount
19	-1%	05	3%
12	-2%	14	3%
24	-3%	33	3%
32	-3%	18	4%
47	-4%	22	4%
		02	5%
		43	5%
6% - 10% Below Expected Cost		6% - 10% Above Expected Cost	
40	-6%	04	6%
11	-7%	13	7%
44	-7%	39	9%
21	-8%	50	10%
11% - 15% Below Expected Cost		11% - 15% Above Expected Cost	
23	-11%	45	11%
10	-12%	30	12%
34	-13%	31	12%
37	-13%	08	13%
15	-15%	17	13%
		16	15%
16% - 20% Below Expected Cost		16% - 20% Above Expected Cost	
01	-16%	27	17%
42	-16%	35	20%
49	-18%	41	20%
09	-20%		
> 20% Below Expected Cost		> 20% Above Expected Cost	
36	-21%	28	22%
48	-21%	20	23%
38	-26%	03	24%
46	-34%	26	24%
07	-35%	29	37%
25	-40%	06	65%

Capital Cost Comparisons

Thirty-nine hospitals have capital costs within $25 of their expected values, as shown in Table 8-9. None have capital costs more than $50 different than their expected values. The highest positive dollar difference is $37 for Hospital (35), and the highest negative dollar differences are -$44 and -$40 for Hospitals (01) and (03) respectively.

In contrast to the dollar difference results, but consistent with the small fraction of total cost represented by capital cost, only ten hospitals, or 20% of the total group, have capital costs within 10% of their expected values, as displayed in Table 8-10. Fifteen institutions

Table 8-9

SUMMARY OF DOLLAR DIFFERENCES FOR CAPITAL COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
$0 - $25 Below Expected Cost		$1 - $25 Above Expected Cost	
Hospital	Amount	Hospital	Amount
19	$0	10	$2
27	-$2	23	$2
17	-$4	20	$3
29	-$4	46	$3
45	-$5	13	$4
28	-$5	31	$5
14	-$0	33	$6
09	-$10	25	$10
11	-$13	06	$11
12	-$13	18	$11
30	-$14	02	$13
38	-$14	36	$13
05	-$16	26	$15
44	-$16	37	$15
21	-$17	49	$16
32	-$17	39	$17
22	-$18	41	$18
48	-$19	42	$22
47	-$21		
08	-$23		
34	-$23		
$26 - $50 Below Expected Cost		$26 - $50 Above Expected Cost	
07	-$28	40	$28
43	-$31	24	$31
50	-$32	16	$32
03	-$40	04	$33
01	-$44	15	$33
		35	$37
$51 - $75 Below Expected Cost		$51 - $75 Above Expected Cost	
(none)		(none)	
> $75 Below Expected Cost		> $75 Above Expected Cost	
(none)		(none)	

exhibit capital costs more than 20% higher than their expected values. The outliers are Hospitals (40) and (16), whose percentage differences are respectively 112% and 107%. Another six hospitals have capital costs at least 50% higher than their expected values.

There are even more negative outliers than positive outliers. Seventeen hospitals, or almost 35% of the total group, have capital costs more than 20% below their expected values. As with positive deviations, there are several sharp outliers in this category -- Hospitals (32), (01), and (50) -- which exhibit respective percentage differences of -100%, -98%, and -86%. Another three hospitals have capital costs at least 50% lower than their expected values, and another five institutions show capital costs 40% to 50% below their expected values.

Table 8-10

SUMMARY OF PERCENTAGE DIFFERENCES FOR CAPITAL COST

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
0% - 5% Below Expected Cost		1% - 5% Above Expected Cost	
Hospital	Amount	Hospital	Amount
19	0%	20	2%
27	-5%	46	3%
		23	4%
		10	5%
6% - 10% Below Expected Cost		6% - 10% Above Expected Cost	
17	-9%	13	6%
29	-9%		
45	-9%		
11% - 15% Below Expected Cost		11% - 15% Above Expected Cost	
14	-15%	33	12%
28	-15%	31	15%
16% - 20% Below Expected Cost		16% - 20% Above Expected Cost	
30	-20%	36	16%
		18	20%
> 20% Below Expected Cost		> 20% Above Expected Cost	
48	-22%	06	22%
44	-26%	02	27%
43	-35%	04	28%
03	-36%	41	35%
07	-38%	49	43%
38	-38%	26	47%
11	-43%	42	48%
22	-44%	25	50%
47	-44%	37	52%
12	-45%	39	53%
08	-49%	24	66%
05	-50%	15	72%
34	-61%	35	78%
21	-65%	16	107%
50	-86%	40	112%
01	-98%		
32	-100%		

Relationships Among the Total and Departmental Comparisons

The convergence of the total and departmental cost comparisons is very strong. The correlation between the total dollar difference (calculated by the actual/expected technique) and the sum of the departmental dollar differences is .997. The degree of common variation between these statistics thus exceeds 99%.

The close convergence of the total and departmental cost comparisons is also demonstrated by Table 8-11. It indicates for each hospital the five departmental dollar differences, the sum of those differences, and the total dollar difference. It then shows the divergence between the total dollar difference and the sum of the departmental dollar differences. This statistic, termed the departmental dollar divergence, is calculated as the latter minus the former. A positive value for this statistic indicates that the sum of the departmental differences is less favorable to the hospital than the total difference; a negative value indicates the reverse.

This table also shows the departmental percentage divergence, which equals the departmental dollar divergence divided by expected total cost (and expressed as a percentage). This statistic is equivalent to the percentage difference between expected total cost and the sum of the expected departmental costs. Its sign has the same meaning as that of the departmental dollar divergence.

As shown in this table, the maximum departmental dollar divergence is $45 for Hospital (20). The only other departmental dollar divergences greater than $20 are $21 for Hospital (25) and $23 for Hospital (46). In fact, only three additional hospitals have a departmental dollar divergence greater than $10. This statistic equals $13 for Hospital (48); $11 for Hospital (32); and -$11 for Hospital (23). Thus, in only six hospitals, or 12% of the total group, does the total dollar difference diverge from the sum of the departmental dollar differences by more than $10.

The same point is shown by the departmental percentage divergences. The maximum for this statistic is 4%, exhibited by Hospital (20). Other than this institution, only Hospitals (25), (46), and (32) have a departmental percentage divergence greater than 2%.

Regression analysis shows that the influence of each departmental dollar difference on the total dollar difference is positive and significant at beyond the .001 level. In this analysis, after the effects of the other departmental differences are taken into account, the ancillary dollar difference has the most powerful impact on the total dollar difference. The capital dollar difference has the least

strong influence on the total dollar difference, and the effects of the remaining three departmental differences are approximately the same.[2]

Similar points emerge from Table 8-11. Consider the three hospitals whose costs exceed their expected values by the greatest amount: Hospitals (03), (06), and (29), which have total dollar differences of $453, $303, and $300, respectively. The two departmental costs most responsible for the cost overage of Hospital (03) are nursing and hotel costs, with administrative cost making a smaller but substantial contribution. Ancillary and capital dollar differences for this institution are negative. In contrast, the primary departmental cost responsible for the cost overage of Hospital (06) is ancillary cost, with administrative cost being next in importance. The dollar differences for the remaining three departmental costs are positive, but small. In further contrast, it is nursing and ancillary costs which mainly account for the cost overage of Hospital (29). Hotel and administrative costs have positive but much smaller dollar differences. The dollar difference for capital cost is slightly negative for this hospital.

A similar phenomenon is observed when the departmental profiles of the three hospitals with the most negative dollar differences are examined. These institutions are Hospitals (14), (38), and (49), whose respective dollar differences are -$156, -$153, and -$160. The main factor accounting for the lower than expected cost of Hospital (14) is ancillary cost, with smaller contributions from nursing and hotel costs. The dollar differences for administrative and capital costs are low. All the departmental costs contribute to the relatively low cost of Hospital (38). In this regard, capital cost is least important and hotel cost most important. The highest departmental dollar difference for Hospital (49) is nursing cost. This institution also has substantial negative dollar differences for hotel and ancillary costs, but its dollar differences for the other two departmental costs are low.

The departmental profiles of these six hospitals are summarized in Table 8-12. The number of pluses or minuses in this table is indicative of the approximate magnitude of the dollar differences.

The differences among hospital departmental profiles can be illustrated in another way. Only seven hospitals, or 14% of the total group, show the same sign for each departmental difference. For about one half of the hospitals, the sign is positive (or negative) for three departmental dollar differences and reversed for the other two differences.

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[2] Association among the five departmental differences (collinearity) is surprisingly modest, and thus does not interfere with the interpretability of this analysis.

Table 8-11

SUMMARY OF TOTAL AND DEPARTMENTAL COST DIFFERENCES

Hosp.	Nurs. Dollar Diff.	Ancil. Dollar Diff.	Hotel Dollar Diff.	Admin. Dollar Diff.	Capit. Dollar Diff.	Sum of Deptl. Dollar Diff.	Total Dollar Diff.	Deptl. Dollar Diver.	Deptl. Percent Diver.
01	$ 29	$ 55	$ 32	$-21	$-44	$ 51	$ 59	$ -8	-1.0%
02	7	28	19	7	13	74	81	-7	-0.9
03	228	-32	210	84	-40	450	453	-3	-0.2
04	-27	37	-105	22	33	-40	-38	-2	-0.1
05	-3	45	-4	4	-16	26	29	-3	-0.5
06	17	167	13	92	11	300	303	-3	-0.3
07	15	23	46	-72	-28	-16	-13	-3	-0.2
08	3	7	-31	19	-23	-25	-20	-5	-0.6
09	54	42	10	-36	-10	60	60	0	0.0
10	-49	-41	-26	-16	2	-130	-127	-3	-0.4
11	7	85	-8	-7	-13	64	66	-2	-0.5
12	1	38	2	-2	-13	26	28	-2	-0.4
13	-21	-17	17	13	4	-4	-3	-1	-0.1
14	-30	-90	-37	4	-9	-162	-156	-6	-0.7
15	-4	-19	-14	-20	33	-24	-23	-1	-0.1
16	19	6	-16	19	32	60	56	4	0.6
17	-11	-19	-8	16	-4	-26	-27	1	0.2
18	-11	-16	4	5	11	-7	-1	-6	-0.7
19	8	-13	12	-1	0	6	5	1	0.2
20	-3	25	1	51	3	77	32	45	4.1
21	5	-21	0	-10	-17	-43	-51	8	1.2
22	10	6	-23	5	-18	-20	-18	-2	-0.3
23	-24	-30	-22	-14	2	-88	-77	-11	-1.6
24	-24	-75	-53	-4	31	-125	-123	-2	-0.3
25	-12	-30	-26	-46	10	-104	-125	21	3.5

Table 8-11 (continued)

Hosp.	Nurs. Dollar Diff.	Ancil. Dollar Diff.	Hotel Dollar Diff.	Admin. Dollar Diff.	Capit. Dollar Diff.	Sum of Deptl. Dollar Diff.	Total Dollar Diff.	Deptl. Dollar Diver.	Deptl. Percent Diver.
26	$ 36	$ 52	$ 37	$ 26	$ 15	$166	$171	$ -5	-1.0%
27	-52	-17	-26	22	-2	-75	-73	-2	-0.3
28	2	0	28	34	-5	59	55	4	0.5
29	116	117	38	35	-4	302	300	2	0.3
30	-2	-36	33	21	-14	2	1	1	0.1
31	8	-26	-1	14	5	0	3	-3	-0.5
32	46	-6	38	-3	-17	58	47	11	2.5
33	-13	-5	-12	4	6	-20	-20	0	0.0
34	-7	-62	-23	-16	-23	-131	-139	8	1.0
35	29	-8	41	24	37	123	133	-10	-1.5
36	41	71	64	-45	13	144	146	-2	-0.2
37	7	-2	19	-12	15	27	27	0	0.0
38	-30	-31	-48	-34	-14	-157	-153	-4	-0.6
39	25	10	20	10	17	82	82	0	0.0
40	54	9	12	-6	28	97	97	0	0.0
41	26	79	-4	28	18	147	147	0	0.0
42	-27	12	34	-18	22	23	33	-10	-1.7
43	18	-62	63	15	-31	3	7	-4	-0.3
44	3	-33	24	-13	-16	-35	-29	-6	-0.6
45	-10	-49	6	14	-5	-44	-38	-6	-0.7
46	-46	11	-23	-58	3	-113	-136	23	2.8
47	-12	-61	-21	-5	-21	-120	-111	-9	-1.3
48	86	73	37	-44	-19	133	120	13	1.0
49	-62	-41	-52	-24	16	-163	-160	-3	-0.4
50	-22	-22	-12	14	-32	-74	-70	-4	-0.5

Table 8-12

DEPARTMENTAL PROFILES FOR SIX HOSPITALS
WHICH ARE OUTLIERS ON THE TOTAL DOLLAR DIFFERENCE

	Nursing Dollar Diff.	Ancil. Dollar Diff.	Hotel Dollar Diff.	Admin. Dollar Diff.	Capital Dollar Diff.	Total Dollar Diff.
Hospital (03)	+++++	-	+++++	+++	-	+++++
Hospital (06)	+	+++++	+	+++	+	+++++
Hospital (29)	++++	++++	+	+	0	+++++
Hospital (14)	-	---	-	0	-	---
Hospital (38)	-	-	--	-	-	---
Hospital (49)	--	--	--	-	+	---

Three conclusions arise from the findings discussed in this section. The first is that the strong convergence between the total and departmental cost comparisons not only provides further evidence of the soundness of the total and departmental cost analyses, but it also makes it easy to use the total and departmental comparisons together. That is, it is not necessary to adjust the departmental results to make them comparable to the total results.

The second conclusion is that while the strength with which the departmental dollar differences impact the total dollar difference varies, each has a highly significant influence. This finding supports the integrity of the departmental cost variables, indicating that each represents an important and different area of hospital performance. It also means that none of the five departmental areas can be relegated to minor importance by a prospective payment program.

The third conclusion is that there is substantial variation among hospital departmental profiles, and that such profiles can provide important insights to a prospective payment program. Both points are evident in Table 8-12. This conclusion will be discussed further in Chapter 10.

Complete Departmental Comparison Results

The findings of the departmental cost comparisons have been summarized and discussed earlier in this chapter. The complete findings of these comparisons are shown in Tables 8-13 through 8-17. The format of these tables is analogous to that of Table 6-1.

Table 8-13

COMPARISON OF ACTUAL AND EXPECTED NURSING COSTS

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
01	$241	$212	$ 29	13.7%
02	226	219	7	3.2
03	782	554	228	41.2
04	559	586	-27	-4.6
05	144	147	-3	-2.0
06	272	255	17	6.7
07	380	365	15	4.1
08	233	230	3	1.3
09	382	328	54	16.5
10	173	222	-49	-22.1
11	105	98	7	7.1
12	128	127	1	0.8
13	295	316	-21	-6.6
14	211	241	-30	-12.4
15	226	230	-4	-1.7
16	199	180	19	10.6
17	169	180	-11	-6.1
18	219	230	-11	-4.8
19	156	148	8	5.4
20	305	308	-3	-1.0
21	189	184	5	2.7
22	228	218	10	4.6
23	171	195	-24	-12.3
24	200	224	-24	-10.7
25	151	163	-12	-7.4

Table 8-13 (continued)

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
26	$163	$127	$ 36	28.3%
27	142	194	-52	-26.8
28	245	243	2	0.8
29	296	180	116	64.4
30	304	306	-2	-0.7
31	175	167	8	4.8
32	149	103	46	44.7
33	241	254	-13	-5.1
34	205	212	-7	-3.3
35	208	179	29	16.2
36	437	396	41	10.4
37	105	98	7	7.1
38	163	193	-30	-15.5
39	163	138	25	18.1
40	153	99	54	54.5
41	269	244	25	10.2
42	131	158	-27	-17.1
43	497	479	18	3.8
44	323	320	3	0.9
45	211	221	-10	-4.5
46	176	222	-46	-20.7
47	175	187	-12	-6.4
48	459	373	86	23.1
49	136	198	-62	-31.3
50	183	205	-22	-10.7

Table 8-14

COMPARISON OF ACTUAL AND EXPECTED ANCILLARY COSTS

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
01	$274	$219	$ 55	25.1%
02	250	222	28	12.6
03	531	563	-32	-5.7
04	635	598	37	6.2
05	187	142	45	31.7
06	428	261	167	64.0
07	400	377	23	6.1
08	207	200	7	3.5
09	400	358	42	11.7
10	182	223	-41	-18.4
11	196	111	85	76.6
12	176	138	38	27.5
13	309	326	-17	-5.2
14	187	277	-90	-32.5
15	238	257	-19	-7.4
16	189	183	6	3.3
17	124	143	-19	-13.3
18	248	264	-16	-6.1
19	139	152	-13	-8.6
20	197	172	25	14.5
21	167	188	-21	-11.2
22	247	241	6	2.5
23	162	192	-30	-15.6
24	154	229	-75	-32.8
25	104	134	-30	-22.4

Table 8-14 (continued)

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
26	$181	$129	$ 52	40.3%
27	170	187	-17	-9.1
28	213	213	0	0.0
29	366	249	117	47.0
30	319	355	-36	-10.1
31	170	196	-26	-13.3
32	101	107	-6	-5.6
33	230	235	-5	-2.1
34	189	251	-62	-24.7
35	168	176	-8	-4.5
36	487	416	71	17.1
37	109	111	-2	-1.8
38	159	190	-31	-16.3
39	158	148	10	6.8
40	120	111	9	8.1
41	326	247	79	32.0
42	159	147	12	8.2
43	414	476	-62	-13.0
44	264	297	-33	-11.1
45	183	232	-49	-21.1
46	158	147	11	7.5
47	114	175	-61	-34.9
48	371	298	73	24.5
49	153	194	-41	-21.1
50	181	203	-22	-10.8

Table 8-15

COMPARISON OF ACTUAL AND EXPECTED HOTEL COSTS

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
01	$191	$159	$ 32	20.1%
02	187	168	19	11.3
03	390	180	210	116.7
04	93	198	-105	-53.0
05	118	122	-4	-3.3
06	197	184	13	7.1
07	235	189	46	24.3
08	144	175	-31	-17.7
09	194	184	10	5.4
10	132	158	-26	-16.5
11	99	107	-8	-7.5
12	116	114	2	1.8
13	205	188	17	9.0
14	147	184	-37	20.1
15	142	156	-14	-9.0
16	130	146	-16	-11.0
17	160	168	-8	-4.8
18	168	164	4	2.4
19	138	126	12	9.5
20	222	221	1	0.5
21	146	146	0	0.0
22	140	163	-23	-14.1
23	133	155	-22	-14.2
24	109	162	-53	-32.7
25	118	144	-26	-18.1

Table 8-15 (continued)

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
26	$146	$109	$ 37	33.9%
27	128	154	-26	-16.9
28	199	171	28	16.4
29	156	118	38	32.2
30	183	150	33	22.0
31	123	124	-1	-0.8
32	136	98	38	38.8
33	167	179	-12	-6.7
34	120	143	-23	-16.1
35	198	157	41	26.1
36	265	201	64	31.8
37	115	96	19	19.8
38	91	139	-48	-34.5
39	140	120	20	16.7
40	103	91	12	13.2
41	169	173	-4	-2.3
42	176	142	34	23.9
43	237	174	63	36.2
44	235	211	24	11.4
45	181	175	6	3.4
46	142	165	-23	-13.9
47	138	159	-21	-13.2
48	300	263	37	14.1
49	103	155	-52	-33.5
50	144	156	-12	-7.7

Table 8-16

COMPARISON OF ACTUAL AND EXPECTED ADMINISTRATIVE COSTS

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
01	$114	$135	$-21	-15.6%
02	142	135	7	5.2
03	427	343	84	24.5
04	374	352	22	6.3
05	119	115	4	3.5
06	233	141	92	65.2
07	136	208	-72	-34.6
08	163	144	19	13.2
09	140	176	-36	-20.5
10	123	139	-16	-11.5
11	87	94	-7	-7.4
12	104	106	-2	-1.9
13	187	174	13	7.5
14	126	122	4	3.3
15	111	131	-20	-15.3
16	144	125	19	15.2
17	136	120	16	13.3
18	133	128	5	3.9
19	114	115	-1	-0.9
20	270	219	51	23.3
21	116	126	-10	-7.9
22	138	133	5	3.8
23	113	127	-14	-11.0
24	127	131	-4	-3.1
25	69	115	-46	-40.0

Table 8-16 (continued)

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
26	$134	$108	$ 26	24.1%
27	155	133	22	16.5
28	189	155	34	21.9
29	129	94	35	37.2
30	190	169	21	12.4
31	130	116	14	12.1
32	94	97	-3	-3.1
33	162	158	4	2.5
34	112	128	-16	-12.5
35	147	123	24	19.5
36	173	218	-45	-20.6
37	81	93	-12	-12.9
38	97	131	-34	-26.0
39	117	107	10	9.3
40	90	96	-6	-6.3
41	168	140	28	20.0
42	98	116	-18	-15.5
43	322	307	15	4.9
44	169	182	-13	-7.1
45	139	125	14	11.2
46	114	172	-58	-33.7
47	121	126	-5	-4.0
48	165	209	-44	-21.1
49	111	135	-24	-17.8
50	153	139	14	10.1

Table 8-17

COMPARISON OF ACTUAL AND EXPECTED CAPITAL COSTS

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
01	$ 1	$ 45	$-44	-97.8%
02	61	48	13	27.1
03	70	110	-40	-36.4
04	151	118	33	28.0
05	16	32	-16	-50.0
06	62	51	11	21.6
07	45	73	-28	-38.4
08	24	47	-23	-48.9
09	59	69	-10	-14.5
10	43	41	2	4.9
11	17	30	-13	-43.3
12	16	29	-13	-44.8
13	72	68	4	5.9
14	52	61	-9	-14.8
15	79	46	33	71.7
16	62	30	32	106.7
17	42	46	-4	-8.7
18	66	55	11	20.0
19	29	29	0	0.0
20	128	125	3	2.4
21	9	26	-17	-65.4
22	23	41	-18	-43.9
23	49	47	2	4.3
24	78	47	31	66.0
25	30	20	10	50.0

Table 8-17 (continued)

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
26	$ 47	$ 32	$ 15	46.9%
27	35	37	-2	-5.4
28	28	33	-5	-15.2
29	43	47	-4	-8.5
30	56	70	-14	-20.0
31	39	34	5	14.7
32	0	17	-17	-100.0
33	55	49	6	12.2
34	15	38	-23	-60.5
35	84	47	37	78.7
36	94	81	13	16.0
37	44	29	15	51.7
38	23	37	-14	-37.8
39	49	32	17	53.1
40	53	25	28	112.0
41	69	51	18	35.3
42	68	46	22	47.8
43	57	88	-31	-35.2
44	46	62	-16	-25.8
45	51	56	-5	-8.9
46	92	89	3	3.4
47	27	48	-21	-43.8
48	69	88	-19	-21.6
49	53	37	16	43.2
50	5	37	-32	-86.5

9

Cost Comparisons for Group II Hospitals

The cost comparison results for Group II hospitals are the subject of this chapter. Both the actual/expected and actual/peer group techniques were applied to Group II hospitals, using the same methods as were employed for Group I institutions. Both techniques are based on the final Group II cost equation, which is discussed in Chapter 5. Since departmental analyses are inappropriate for Group II hospitals, no departmental cost comparisons were undertaken for these institutions.

The first section of this chapter discusses the actual/expected comparison results, and the second section describes the actual/peer group comparison findings. The final section examines the degree of convergence between the findings of the two comparison techniques.

Actual/Expected Cost Comparisons

The results obtained by application of the actual/expected technique are presented in Table 9-1. The dollar and percentage differences are calculated in the same manner for Group II hospitals as for Group I institutions. Accordingly, a positive sign for these statistics means that a hospital's actual cost exceeds its expected cost, and a negative sign has the reverse significance.

As shown in Table 9-2, 13 hospitals, or 45% of the total group, have actual costs within $50 of their expected costs. An additional six institutions have dollar differences greater than ±$50, but less than ±$100. Almost two thirds of Group II hospitals thus have actual costs within $100 of their expected costs.

The actual costs of five hospitals are $101 to $150 below their expected costs. Only one hospital [Hospital (60)] has an actual cost more than $150 lower than its expected cost. In contrast, only two institutions -- Hospitals (77) and (72) -- exhibit actual costs $101 to $150 higher than their expected costs, but an additional two hospitals have actual costs more than $150 higher than their expected costs. Hospital (73) has an actual cost which is $256 over its expected cost, and Hospital (68)'s actual cost exceeds its expected cost by $536. Since the maximum positive dollar difference

Table 9-1

COMPARISON OF ACTUAL AND EXPECTED COSTS

Hospital	Actual Cost	Expected Cost	Dollar Difference	Percentage Difference
51	$1075	$1037	$ 38	3.7%
52	751	687	64	9.3
53	848	818	30	3.7
54	613	640	-27	-4.2
55	517	605	-88	-14.5
56	605	596	9	1.5
57	596	592	4	0.7
58	571	622	-51	-8.2
59	536	521	15	2.9
60	442	601	-159	-26.5
61	682	695	-13	-1.9
62	614	723	-109	-15.1
63*	768	882	-114	-12.9
64	356	504	-148	-29.4
65	524	545	-21	-3.9
66	1019	1116	-97	-8.7
67	544	444	100	22.5
68*	1426	890	536	60.2
69	619	596	23	3.9
70	516	647	-131	-20.2
71	442	409	33	8.1
72	1144	1026	118	11.5
73	859	603	256	42.5
74*	315	444	-129	-29.1
75	823	833	-10	-1.2
76	451	451	0	0.0
77	612	510	102	20.0
78	863	795	68	8.6
79	675	682	-7	-1.0

* The three hospitals excluded from the cost analyses but included in the cost comparisons are Hospitals (63), (68), and (74). Values for the four cost determinants were derived from actual data for these three hospitals.

for Group I is $453 for Hospital (03), Hospital (68) has the highest positive dollar difference for both groups of hospitals. The maximum negative dollar difference is almost the same for the two groups: -$159 for Hospital (60) in Group II, and -$160 for Hospital (49) in Group I.

Table 9-2

SUMMARY OF DOLLAR DIFFERENCES

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
$0 - $50 Below Expected Cost		$1 - $50 Above Expected Cost	
Hospital	Amount	Hospital	Amount
76	$0	57	$4
79	-$7	56	$9
75	-$10	59	$15
61	-$13	69	$23
65	-$21	53	$30
54	-$27	71	$33
		51	$38
$51 - $100 Below Expected Cost		$51 - $100 Above Expected Cost	
58	-$51	52	$64
55	-$88	78	$68
66	-$97	67	$100
$101 - $150 Below Expected Cost		$101 - $150 Above Expected Cost	
62	-$109	77	$102
63	-$114	72	$118
74	-$129		
70	-$131		
64	-$148		
> $150 Below Expected Cost		> $150 Above Expected Cost	
60	-$159	73	$256
		68	$536

Similar to Group I, 17 hospitals, or almost 60% of this group, have actual costs within 10% of their expected costs, as displayed in Table 9-3. Three hospitals have actual costs more than 20% below their expected costs, and another three hospitals have costs more than 20% above their expected costs.

The most extreme negative and positive percentage deviations are higher for Group II hospitals than for Group I institutions. In Group II, Hospitals (64) and (74) exhibit the maximum negative percentage difference of -29%, and Hospital (60) has a negative percentage deviation of -26%. Group I also has three hospitals with percentage differences more than 20% below expected costs, but these differences only exceed 20% by a small margin. The percentage difference for Hospitals (38) and (49) is -22%, and that for Hospital (25) is -21%.

The same pattern is evident in the positive percentage deviations. In Group II, Hospital (68) has an actual cost which is 60% higher than its expected cost, and Hospital (73) exhibits an actual cost that exceeds its expected cost by 42%. In Group I, the maximum percentage difference is 43% for Hospital (29), and the next highest value for this statistic is 34% for both Hospitals (06) and (26).

Table 9-3

SUMMARY OF PERCENTAGE DIFFERENCES

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
0% - 5% Below Expected Cost		1% - 5% Above Expected Cost	
Hospital	Amount	Hospital	Amount
76	0%	57	1%
75	-1%	56	2%
79	-1%	59	3%
61	-2%	51	4%
54	-4%	53	4%
65	-4%	69	4%
6% - 10% Below Expected Cost		6% - 10% Above Expected Cost	
58	-8%	71	8%
66	-9%	52	9%
		78	9%
11% - 15% Below Expected Cost		11% - 15% Above Expected Cost	
63	-13%	72	12%
55	-15%		
62	-15%		
16% - 20% Below Expected Cost		16% - 20% Above Expected Cost	
70	-20%	77	20%
> 20% Below Expected Cost		> 20% Above Expected Cost	
60	-26%	67	23%
64	-29%	73	42%
74	-29%	68	60%

Actual/Peer Group Cost Comparisons

Composition of the Peer Groups

The four conditions employed in the construction of peer groups for Group I hospitals were also used to develop peer groups for Group II institutions. These conditions are:

(1) The average expected cost of the peer group members must be within 3% of the primary hospital's expected cost.

(2) Each peer group should have four to six members.

(3) Each peer group member should have an expected cost within 10% of the primary hospital's expected cost.

(4) The value of each cost determinant for each peer group member must be within two standard deviations of the value of the corresponding cost determinant for the primary hospital.

The four-tier peer group classification system developed for Group I was also applied to Group II. It is summarized below.

Fully Satisfactory -- the peer group satisfies all four conditions.

Largely Satisfactory -- the peer group must satisfy Condition (1). If the peer group has only three members, it must satisfy Conditions (3) and (4). If the peer group has four to six members, Condition (4) may be narrowly violated and/or Condition (3) may be moderately broken.

Minimally Satisfactory -- the peer group must meet Conditions (1) and (2), but Conditions (3) and/or (4) may be substantially violated as long as the integrity of the group does not appear compromised.

Unsatisfactory -- a peer group cannot be constructed meeting even the relaxed standards of the minimally satisfactory tier.

As indicated in Table 9-4, 12 hospitals have fully satisfactory peer groups; ten have largely satisfactory peer groups; three have minimally satisfactory peer groups; and four have unsatisfactory peer groups. Thus, 41% of Group II hospitals have fully satisfactory groups; 35% have largely satisfactory groups; 10% have minimally satisfactory groups; and 14% do not have a satisfactory group. These results are somewhat similar to the findings for Group I. Fifty-two percent of Group I hospitals have fully satisfactory groups; 32% have largely

satisfactory groups; 8% have minimally satisfactory groups; and an additional 8% do not have a satisfactory group. Hence, the principal differences between Groups I and II are that a higher fraction of the former have fully satisfactory peer groups, and a higher fraction of the latter have unsatisfactory peer groups.

Table 9-4

COMPOSITION OF PEER GROUPS

FULLY SATISFACTORY GROUPS

Primary Hospital	Peer Group Hospitals
52	54 79 62 70
54	52 70 55 73 58 79
55	54 60 56 69 57 73
56	54 58 55 60 57 73
57	55 60 56 69 58
58	54 60 55 70 56 73
60	55 58 56 69 57 73
62	52 79 61 78
69	54 58 55 60 57 65
70	52 61 55 69 58 79
73	54 58 55 60 56 65
79	52 62 54 70 58

Table 9-4 (continued)

LARGELY SATISFACTORY GROUPS

Primary Hospital	Peer Group Hospitals
53	54 68 58 72 63 75
59	57 69 64 67
61	52 70 54 79 62
63	51 75 53 68
64	59 69 65 74 67 77
65	56 69 57 76 64 77
67	64 76 71 74
68	53 75 63 72
75	53 78 63 68
77	57 65 59 67 64 76

MINIMALLY SATISFACTORY GROUPS

Primary Hospital	Peer Group Hospitals
74	64 76 67 71
76	64 74 67 77 71
78	51 62 52 75 61 79

HOSPITALS WITH UNSATISFACTORY GROUPS

(51), (66), (71), (72)

Group II hospitals do not have any mutually exclusive or identical peer groups. Hence, the unique peer group approach has strong advantages for Group II hospitals, as it has for Group I institutions. Like Group I, certain commonalities exist among the Group II peer groups. Hospitals (55), (56), (57), and (60) have at least the other three hospitals in their peer groups. Hospitals (69) and (73) have

five common members, but not each other, in their six-member peer groups. Analogous to Hospitals (02) and (10) in Group I, Hospitals (67) and (74) have three common members and each other in their peer groups. Additionally, Hospitals (56), (69), and (73) have four common hospitals in each of their six-member peer groups.

Thirteen hospitals have six-member peer groups; four hospitals have five-member peer groups; and eight hospitals have four-member groups. Unlike Group I, no Group II hospital has a peer group with only three members.

These 25 peer groups include 130 hospitals. Thus, as in Group I, the average Group II hospital is a member of five peer groups. However, Hospital (66) is not in any peer group, and does not have a satisfactory peer group of its own. In contrast, Hospitals (54) and (58) are members of nine peer groups, and Hospital (55) belongs to eight groups.

Cost Comparisons

The actual/peer group comparison results are displayed in Table 9-5, which also identifies the type of each hospital's peer group. Both dollar and percentage differences are shown in this table. These two statistics are calculated in an identical manner for Group II hospitals as for Group I institutions. Hence, a positive value for these statistics indicates that a hospital's actual costs are higher than those of its peers, and a negative value has the reverse meaning.

Table 9-5

COMPARISON OF ACTUAL AND PEER GROUP COSTS

Hospital	Type of Peer Group	Actual Cost	Mean Actual Cost of Peer Group	Dollar Difference	Percentage Difference
51	U	$1075	$ -	$ -	$ -
52	FS	751	605	146	24.1%
53	LS	848	891	-43	-4.8
54	FS	613	648	-35	-5.4
55	FS	517	622	-105	-16.9
56	FS	605	600	5	0.8
57	FS	596	551	45	8.2
58	FS	571	592	-21	-3.5
59	LS	536	529	7	1.3
60	FS	442	628	-186	-29.6
61	LS	682	634	48	7.6
62	FS	614	743	-129	-17.4
63	LS	768	1043	-275	-26.4
64	LS	356	525	-169	-32.2
65	LS	524	540	-16	-3.0
66	U	1019	-	-	-
67	LS	544	391	153	39.1
68	LS	1426	896	530	59.2
69	FS	619	544	75	13.8
70	FS	516	636	-120	-18.9
71	U	442	-	-	-
72	U	1144	-	-	-
73	FS	859	545	314	57.6
74	MS	315	448	-133	-29.7
75	LS	823	976	-153	-15.7
76	MS	451	454	-3	-0.7
77	LS	612	501	111	22.2
78	MS	863	770	93	12.1
79	FS	675	613	62	10.1

As shown in Table 9-6, approximately one half of Group II hospitals have actual costs within $100 of their peer group means. The dollar difference is smaller than ±$50 for three fourths of these hospitals. Eight hospitals (as opposed to six hospitals in the actual/expected comparison) exhibit a cost performance substantially more favorable than their peer group means. Hospitals (55), (70), (62), and (74) have costs $101 to $150 below their peer group means, while Hospitals (75), (64), (60), and (63) exhibit costs more than $150 below their peer group means. The latter three institutions have negative dollar differences exceeding the maximum negative dollar difference for the actual/expected comparisons -- Hospital (60)'s -$159. In these findings the dollar difference is -$169 for Hospital (64), -$186 for Hospital (60), and -$275 for Hospital (63).

Table 9-6

SUMMARY OF DOLLAR DIFFERENCES

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
$0 - $50 Below Peer Group Mean		$1 - $50 Above Peer Group Mean	
Hospital	Amount	Hospital	Amount
76	-$3	56	$5
65	-$16	59	$7
58	-$21	57	$45
54	-$35	61	$48
53	-$43		
$51 - $100 Below Peer Group Mean		$51 - $100 Above Peer Group Mean	
(none)		79	$62
		69	$75
		78	$93
$101 - $150 Below Peer Group Mean		$101 - $150 Above Peer Group Mean	
55	-$105	77	$111
70	-$120	52	$146
62	-$129		
74	-$133		
> $150 Below Peer Group Mean		> $150 Above Peer Group Mean	
75	-$153	67	$153
64	-$169	73	$314
60	-$186	68	$530
63	-$275		

Two hospitals have actual costs which exceed their peer group means by $101 to $150. Three hospitals [Hospitals (67), (73), and (68)] have actual costs more than $150 above their peer group means. The

dollar difference ($530) for the latter hospital is similar to its actual/expected dollar difference ($536). In contrast, the former two hospitals have dollar differences of $153 and $314 respectively in these comparisons, as opposed to dollar differences of $100 and $256 in the actual/expected comparisons.

Only 40% of the hospitals have actual costs within 10% of their peer group means, as indicated in Table 9-7. In contrast, 60% of the hospitals are within this percentage difference in the actual/expected comparison. Five hospitals have actual costs more than 20% above their peer group means, and four institutions show actual costs more than 20% below their peer group means. The maximum positive and negative percentage differences are similar in the two comparisons. In both comparisons Hospital (68) exhibits the highest positive percentage difference -- 60% in the actual/expected comparison and 59% in this comparison. The highest negative percentage difference is -32% for Hospital (64) in this comparison and -29% for the same hospital and Hospital (74) in the actual/expected comparison.

Table 9-7

SUMMARY OF PERCENTAGE DIFFERENCES

HOSPITALS WITH ACTUAL COST:		*HOSPITALS WITH ACTUAL COST:*	
0% - 5% Below Peer Group Mean		1% - 5% Above Peer Group Mean	
Hospital	Amount	Hospital	Amount
76	-1%	56	1%
65	-3%	59	1%
58	-4%		
53	-5%		
54	-5%		
6% - 10% Below Peer Group Mean		6% - 10% Above Peer Group Mean	
(none)		57	8%
		61	8%
		79	10%
11% - 15% Below Peer Group Mean		11% - 15% Above Peer Group Mean	
(none)		78	12%
		69	14%
16% - 20% Below Peer Group Mean		16% - 20% Above Peer Group Mean	
75	-16%	(none)	
55	-17%		
62	-17%		
70	-19%		
> 20% Below Peer Group Mean		> 20% Above Peer Group Mean	
63	-26%	77	22%
60	-30%	52	24%
74	-30%	67	39%
64	-32%	73	58%
		68	59%

Similarity of the Comparison Results

The correlation between the actual/expected dollar difference and the actual/peer group dollar difference is .94. Hence, the degree of common variation between these statistics is 88%. There is a similar correlation between the percentage differences, .95, so that the extent of common variation between these statistics is 90%.

Both these correlations are higher than the corresponding correlations for Group I -- .86 for the dollar differences and .84 for the percentage differences. Hence, there is stronger convergence between the findings of the two techniques for Group II than for Group I. Nonetheless, there is still sufficient variation to make the results of the two techniques substantially different for individual hospitals, as will be pointed out shortly.

As in Group I, the convergence between the techniques is similar for those hospitals with fully satisfactory peer groups and for those institutions with largely satisfactory peer groups. Further, those hospitals with minimally satisfactory peer groups are not responsible for the divergence between the techniques.

Table 9-8 compares the results of the two cost comparison techniques for each hospital. It indicates the dollar and percentage divergences, which are calculated in the same way for Group II institutions as for Group I hospitals. Hence, if these statistics are positive, the actual/peer group comparison is less favorable to the hospital than the actual/expected comparison; and if these statistics are negative, the reverse is true.

The average dollar divergence for the 25 hospitals is zero, and several hospitals have very low dollar divergences. This statistic is no higher than ±$5 for Hospitals (76), (56), (74), and (65); only -$6 for Hospital (68); and -$8 for Hospitals (54) and (59). In contrast, nine hospitals, or approximately 35% of the total group, have dollar divergences exceeding ±$50. While the dollar divergences for three of these hospitals are only modestly higher than ±$50, this statistic is large for two hospitals: -$143 for Hospital (75) and -$161 for Hospital (63).

The percentage divergence is less than ±5% for 15 hospitals, or 60% of the total group. Thus, minor divergence between the two comparison techniques occurs for a greater proportion of Group II hospitals than Group I hospitals (50%). The percentage divergence is greater than ±5% but less than ±10% for five hospitals, or 20% of Group II. In contrast, almost one third of Group I hospitals fall into this category. However, for another five hospitals, or 20% of Group II, the percentage divergence is greater than ±10%. Similarly, almost 20% of Group I hospitals exhibit a percentage divergence of at least ±10%. Consequently, for approximately the same proportion of Group I and Group II hospitals, the divergence between the findings of the comparison techniques is sufficient to modify the implications of the cost comparison results.

Table 9-8

COMPARISON OF THE RESULTS OF THE TWO TECHNIQUES

Hospital	Type of Peer Group	Actual/ Expected Dollar Difference	Actual/ Peer Group Dollar Difference	Dollar Divergence	Percentage Divergence
51	U	$ 38	$ -	$ -	-
52	FS	64	146	82	11.9%
53	LS	30	-43	-73	-8.9
54	FS	-27	-35	-8	-1.3
55	FS	-88	-105	-17	-2.8
56	FS	9	5	-4	-0.7
57	FS	4	45	41	6.9
58	FS	-51	-21	30	4.8
59	LS	15	7	-8	-1.5
60	FS	-159	-186	-27	-4.5
61	LS	-13	48	61	8.8
62	FS	-109	-129	-20	-2.8
63	LS	-114	-275	-161	-18.3
64	LS	-148	-169	-21	-4.2
65	LS	-21	-16	5	0.9
66	U	-97	-	-	-
67	LS	100	153	53	11.9
68	LS	536	530	-6	-0.7
69	FS	23	75	52	8.7
70	FS	-131	-120	11	1.7
71	U	33	-	-	-
72	U	118	-	-	-
73	FS	256	314	58	9.6
74	MS	-129	-133	-4	-0.9
75	LS	-10	-153	-143	-17.2
76	MS	0	-3	-3	-0.7
77	LS	102	111	9	1.8
78	MS	68	93	25	3.1
79	FS	-7	62	69	10.1

10

Application of Cost Comparison Results

The objective of this chapter is to discuss the appropriate use of the cost comparison findings by a prospective payment program (or by any program assessing hospital costs). It has four specific topics. First, the chapter discusses in general how the comparison results can be employed by a prospective payment program. Second, it describes how the actual/expected and actual/peer group comparison results can be used together in an integrated approach based upon their relative advantages. Third, it shows how the departmental cost comparisons can be used to focus the overall perspective obtained from the total cost comparisons. Fourth, the chapter discusses modifications that should be considered, but not necessarily adopted, in future revisions and/or applications of the project findings.

Utilization of the Comparison Findings

The strength of the comparison results is that they are based directly on the most important determinants of hospital cost in Colorado. They respond to the question: How do Hospital X's actual costs compare with its expected costs,[1] given its values for the cost determinants? The comparison findings thus provide an overview of each hospital's relative cost performance.

However, the comparison findings do not take into account circumstances unique to a single hospital or to only a few hospitals. In fact, as emphasized earlier, it is explicitly not their purpose to take such factors into account. This does not mean that the comparisons cannot consider the impact of a factor that characterizes a small number of hospitals. The long-term care variable is an example of successfully taking into account such a factor. Only six of the 50 Group I hospitals are involved in long-term care; yet this factor is a final cost determinant. The same argument applies to medical education involvement, but to a lesser extent since more Group I hospitals are so involved. Nonetheless, the cost comparisons are not designed to consider such idiosyncratic factors as a natural disaster striking a hospital, sudden resignation of the hospital's top administrative staff, relocation of several physicians, or a rapid change in economic activity produced by a long strike.

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[1] In this context expected costs are being used in a generic sense to encompass the standards in both comparison techniques -- expected cost calculated directly from the cost equation and average actual cost of the peer group members.

Given this point, the prospective payment program faces two important questions in using the cost comparisons. First, to what extent is a hospital's dollar difference due to endogenous variables and/or to unique factors beyond the control of the hospital? Second, to what degree does the program consider that fraction of the dollar difference produced by endogenous variables to be justifiable from a health care delivery perspective? These questions are important since they influence the stance the program should take toward a hospital's dollar difference.

If a hospital has a positive dollar difference, it should not be penalized for that fraction of its dollar difference occasioned by unique circumstances outside its influence. The rationale is the same as that which mandates the inclusion in the cost analyses of exogenous factors which characterize a greater number of Colorado hospitals.[2] Similarly, the hospital should not be penalized for that portion of its dollar difference produced by variation in endogenous factors, if the prospective payment program concludes that such variation is justifiable based upon community needs and cost/benefit considerations. In this regard, close liaison with a health planning program is desirable.[3] In contrast, the hospital should be penalized for that part of its dollar difference which is due to variation in endogenous factors which the program feels are not justifiable. Analogous principles apply to hospitals with a negative dollar difference.

To illustrate these points, consider Hospital (41), which has a dollar difference of $147 (in the actual/expected comparisons). Perhaps this hospital is located in an area in which there has been a dramatic economic change during the last two years. As a consequence, its costs, especially its labor expenses, are higher. The prospective payment program and the hospital may concur that this unique locational circumstance accounts for about one third, or $50, of the $147 dollar difference. Hence, this hospital's estimated cost should be adjusted accordingly, i.e., increased by $50.

Perhaps this same hospital operates a satellite facility, which has been open for only a year, and whose costs and other statistics are included in this hospital's data. Suppose that the designated planning agency informs the prospective payment program that this satellite facility is desirable from an overall health care delivery perspective, and that the program recognizes that the costs of this

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[2] This is true since both exogenous factors and unique hospital circumstances are outside the influence of individual hospitals. However, by definition the former apply to more hospitals than the latter.

[3] A close working relationship between health planning agencies and the Colorado Hospital Commission is envisioned by the law establishing the latter.

satellite facility are now somewhat higher because it is still in the start-up phase.[4] Suppose further that the program and the hospital agree that the satellite facility's net contribution to the hospital's dollar difference is approximately $50, or another one third of the total dollar difference. Again, this hospital's expected cost should be adjusted accordingly, i.e., increased by another $50.

Perhaps this hospital is also characterized by a relatively low level of labor productivity, which accounts for most of the remaining $47 of its dollar difference. In this instance, the hospital's expected cost should not be further adjusted, since labor productivity is an endogenous factor well within the control of the hospital. Hence, the program should direct its attention and incentives toward inducing this hospital to improve its labor productivity.

As implied by this example, expected costs should only be adjusted because of major factors whose probable impact on cost is substantial. Equally important, the cost adjustment factors should generally be ones not considered in the analyses. For example, specialized services were taken into account in the Group I analyses and found to have an insignificant effect. Therefore, except in unusual instances, the presence of several specialized services in a Group I institution should not be accepted as a valid reason for the adjustment of expected cost.

After a hospital's expected cost has been adjusted for its unique circumstances and/or justifiable variation in its endogenous factors, the resulting statistic -- adjusted expected cost -- can be used directly as the hospital's prospective rate, after the application of an appropriate inflation factor. However, this approach may prove difficult in the early years of a prospective payment program, since the dollar differences for some hospitals may be large even after the adjustments described above. Hence, it may be desirable to establish prospective rates through a sliding scale, in which a hospital is progressively rewarded or penalized as its actual cost diverges from its adjusted expected cost.

Shown below is an example of a sliding scale designed for hospitals with positive dollar differences.[5] The base in this scale is the

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[4] The Colorado Hospital Commission law recognizes the importance of such start-up expenses. It gives each new facility approved by the appropriate planning agency a grace period of three years before the Commission is to consider its utilization rate in approving subsequent prospective budgets for the hospital.

[5] A somewhat similar sliding scale was described by Shuman, Wolfe, and Hardwick (1972) in their study of Western Pennsylvania hospitals.

hospital's adjusted expected cost, and the levels are cumulative. That is, the dollar amount from Level A is added to the base, the dollar amount from Level B is added to that sum, and the same procedure is continued through Level E. At each level in the scale an inflation factor can be applied. An analogous sliding scale can be used for hospitals with a negative dollar difference.

Level A: For the amount of actual cost within 5% of adjusted expected cost, the entire amount is added to the latter.

Level B: For the amount of actual cost between 5% and 10% above adjusted expected cost, 75% of this amount is added to the latter.

Level C: For the amount of actual cost between 10% and 15% above adjusted expected cost, 50% of this amount is added to the latter.

Level D: For the amount of actual cost between 15% and 20% above adjusted expected cost, 25% of this amount is added to the latter.

Level E: For the amount of actual cost more than 20% above adjusted expected cost, nothing is added to the latter.

To illustrate the operation of the sliding scale, consider a hospital whose actual and adjusted expected costs are respectively $1250 and $1000. Omitting the inflation factor, this hospital's prospective rate would be $1125, which is the sum of the adjusted expected cost ($1000), the entirety of the cost overage up to 5% ($50), 75% of the cost overage between 5% and 10% ($38), 50% of the cost overage between 10% and 15% ($25), 25% of the cost overage between 15% and 20% ($12), and none of the cost overage greater than 20%.

Another important use of the cost comparison results is as a standard for determining the extent to which individual hospitals will be reviewed. It appears advisable to individually review all Group I hospitals, or at least the larger institutions which account for the substantial majority of Colorado hospital costs, since the adjustment process can result in decreases as well as increases in expected costs.[6] However, since negative adjustments will be less

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[6] As an example of a negative adjustment to expected costs, suppose a local government or a private corporation subsidized a hospital by paying its capital costs. If the prospective payment program concludes that this subsidy is appropriate, i.e., that it should be paid by the current subsidizers rather than by the third-party payors in the state, then the expected cost of this hospital should be revised accordingly.

common than positive ones, it is also advisable for the program to concentrate its efforts on those Group I hospitals with significant positive dollar and/or percentage differences.

Group II hospitals account for only 3% of hospital costs in Colorado. Hence, it seems prudent to establish an acceptable range around the expected cost of each Group II hospital. For example, the program might decide to accept without adjustment the expected costs of those hospitals with a percentage difference less than ±5% (or even ±10%), and to correspondingly pay such hospitals their actual costs.[7] Depending upon the program's resources[8] and emphases, it may also be desirable to extend this policy to smaller Group I institutions.

In short, the cost comparison results can be used for two primary objectives by a prospective payment program. The first is to establish prospective rates for individual hospitals which reflect each hospital's values for the cost determinants. The second is to determine the depth of individual hospital budget review. For the latter purpose, the cost comparisons must necessarily be employed in their unadjusted form, since the adjustment process is one facet of the budget review procedure. However, with the exception of Group II and possibly small Group I hospitals which have modest percentage differences, comparison findings should not be used for the former purpose unless they have been adjusted to take into account individual hospital circumstances.

In this report hospital rates are stated in terms of a single charge per admission in order to avoid undue complexity. However, as long as the prospective payment program reviews and approves the total hospital budget, the points made in terms of a single charge per admission apply equally to a more complex rate structure in which different rates are charged for different services.[9]

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[7] A sound argument can be advanced that in order to give these hospitals appropriate incentives, they should be paid the higher of actual cost or expected cost.

[8] The Colorado Hospital Commission appears to be adequately funded. Equally important, the law creating the Commission gives it an earmarked source of funding independent of the state budget. The Commission may annually assess hospitals an amount which cannot exceed .07% of the annual operating expenses of each hospital. The law also specifies a sum of $221,000 to cover the first nine months of the Commission's operations, which commence 1 October 1977.

[9] The Colorado Hospital Commission is directed by its enacting law to review and approve each hospital's prospective budget and "revenue indicators." The latter are defined as the prospective financial requirements of a "revenue center" (a hospital unit providing distinctive services) divided by the estimated units of service to be provided by the revenue center. Hence, it will be possible for the Commission to use the cost comparison findings in a manner similar to that described in this section.

Integration of the Two Comparison Techniques

There is significant divergence between the actual/expected comparison results and the actual/peer group comparison findings for both Groups I and II, although it is higher for the former than for the latter. The correlation between the findings of the two techniques approximates .85 for Group I. Hence, the degree of common variation between the findings for this group approximates 75%. While the convergence between the comparison results thus clearly exceeds the divergence between these findings, the latter is still sufficient to affect the conclusions drawn from the cost comparison findings for some hospitals. Therefore, an important issue is the relative strengths and weaknesses of the two comparison techniques, and the consequent reliance that should be placed on either or both techniques.

The principal strength of the actual/expected comparisons is that they are more accurate for a given time period than the actual/peer group comparisons. One reason is that the former comparisons take into account for each hospital the cumulative experience of Group I (or Group II) hospitals. For example, the regression coefficients used in the Group I cost comparisons are derived from the characteristics of all the institutions included in the Group I analyses. This difference between the two techniques contributes to the divergence between their findings.[10]

In addition, the actual/peer group comparisons suffer from two specific weaknesses. The first and most evident is that it may not be possible to construct a satisfactory peer group for each hospital -- a possibility which materialized in both Groups I and II. In each group, four hospitals do not have a satisfactory peer group. Further, there are four hospitals in Group I and three in Group II which have minimally satisfactory peer groups, whose stability over time is less certain.

The second weakness is that the peer group's average actual cost, which is the standard of comparison in this technique, can be appreciably affected by the actual cost of an outlier hospital. Hospital (06) is such an outlier; its dollar difference is $303 in the actual/expected comparison. This hospital is a member of eight different peer groups. The results for each of the corresponding eight hospitals are more favorable in the actual/peer group comparison than in the actual/expected comparison. All of these peer groups are fully or largely satisfactory, and most have six members. Thus this factor is also partially responsible for the divergence between the findings of the two techniques.

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[10] While peer group construction is founded on the final cost equation, the standard of comparison in this technique is calculated from the actual costs of three to six hospitals. Thus, this comparison standard is not as directly based on the cost equation findings as is the expected cost statistic.

In distinction to their accuracy for a given time period, the actual/peer group comparisons may be more useful over time than the actual/expected comparisons. Given the usual inflation rate in the hospital sector even with an operational prospective payment program, the actual/expected comparisons rapidly become outdated, making it necessary to update such comparisons with an inflation factor(s). Such factors may be arbitrary or may be carefully considered, but in the past they have had the common characteristic of not being founded on the major cost determinants. In contrast, the results of the actual/peer group technique can be continually updated as long as the peer group remains stable, i.e., appropriate to the primary hospital. It was for this reason that the fourth condition for peer group construction (i.e., the two standard deviation constraint on the cost determinants) was devised.

To take advantage of their comparative strengths, the best approach is to use the actual/expected technique to establish each hospital's expected cost for the base period, and then to update that expected cost with inflation rates obtained from the actual/peer group comparisons.

In more detail, the first step is to develop tables analogous to Tables 6-1 and 9-1 for the base period (or to use those tables if the base period is the June 1975 fiscal year). The next step is to determine the average actual cost of each peer group during the next annual reporting period. The peer group mean for the second reporting period is then compared to the peer group mean for the first reporting period in order to determine each peer group's rate of inflation between the first and second reporting periods. This inflation rate is then applied to the primary hospital's expected cost for the first reporting period in order to determine its expected cost for the second reporting period. This procedure is repeated for subsequent reporting periods until a new cost analysis is performed which establishes a new set of expected costs for a new base period.[11]

A refinement of this technique is to annually update the cost analyses, the actual/expected comparisons, and the actual/peer group comparisons.

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[11] Inflation rates serve two general purposes for a prospective payment program. First, inflation rates are necessary in order to convert the comparison standard from the base period to the current period. The inflation rates calculated from the actual/peer group comparisons are well suited for this purpose.

The other purpose of inflation rates is to project current costs and comparison standards into the future. The use of inflation factors in this way is addressed later in this chapter. In addition, as noted earlier, inflation rates of this type can be incorporated in sliding scales such as the one described in the previous section in order to calculate prospective rates.

The latter can then be employed to establish inflation factors for interim periods of less than a year. In our judgment, this approach should be adopted. Our rationale is that the pace of change in the hospital industry is sufficiently rapid that the cost analyses and comparisons should be updated annually to be equitable to both hospitals and consumers. However, a comprehensive revision of the cost comparison findings is not necessary each year. Instead, it appears sufficient to undertake such revisions every three years.

Both the annual updatings and the comprehensive revisions should include the conduct of new cost analyses and the calculation of new cost comparisons, including the creation of new peer groups as indicated. The latter, but not the former, should also include an in-depth review of the substantive framework, a consideration of new variables and data sources, and a detailed investigation of underlying analytical relationships.

Use of Departmental Cost Comparisons

The departmental cost comparisons point out for Group I hospitals those hospital departmental areas where cost performance is more or less favorable. To illustrate their utilization, reconsider Table 8-12. The subject of this table is the three institutions [Hospitals (03), (06), and (29)] whose actual costs exceed their expected costs by the largest margin, and the three institutions [Hospitals (14), (38), and (49)] whose actual costs are lower than their expected costs by the greatest amount.

Based upon the departmental profiles shown in this table, discussions between a prospective payment program and Hospital (03) should center on nursing and hotel costs, with a secondary focus being administrative cost. In contrast, negotiations with Hospital (06) should emphasize ancillary cost, and to a lesser extent, administrative cost. In further distinction, discussions with Hospital (29) should stress nursing and ancillary departments. Thus, in each instance the departmental profiles target specific hospital departmental areas as candidates for intensive review.

The departmental profiles can also be used in a similar way for those hospitals with negative dollar differences. However, their role is less important for such hospitals since the prospective payment program, at least in its early years, should concentrate its attention on those hospitals with a positive dollar difference.

Since each departmental dollar difference has a sizeable influence on the total dollar difference, it is important for a prospective payment program to consider each of the five departmental dollar differences -- a process facilitated by the strong convergence between the total and departmental results. The correlation between the total dollar difference and the sum of the departmental dollar differences

is .997, so that the degree of common variation between these statistics is 99.4%.

The departmental cost comparisons are calculated using the actual/expected technique. They can be updated through an approach analogous to that described earlier for the total cost comparisons. This procedure can use either an inflation factor for the entire hospital calculated through the peer group approach (i.e., the same inflation rate for each departmental area), or a set of departmental inflation rates calculated by creating a different peer group for each departmental area in each hospital. If utilized, departmental peer group construction should be based on principles similar to those used in the creation of peer groups for the entire hospital.

Because of their close relationships with the total cost results, new departmental cost analyses should be conducted and new departmental cost comparisons should be calculated as part of both the annual updatings and comprehensive revisions of the cost comparison results.[12]

Future Modifications

One modification that should be considered in the future is revision of the exogenous variable set. Such a change can take three forms -- deletions, additions, and substitutions. As emphasized earlier, the length of time that a prospective payment program has been operating has a major influence on whether factors should be considered exogenous or endogenous. It is consequently appropriate for factors to be progressively shifted from the short-run exogenous classification to the endogenous category as the operational life of the program increases. A prime candidate for such a transfer in the near future is specialized service mix. Such a shift would be academic at this point, however, since this factor does not significantly affect Group I total or departmental costs. The same point applies to basic service mix for Group II hospitals. Nonetheless, an important consideration in future project revisions remains the possible deletion of factors from the exogenous category.

Another possibility is to add factors to the exogenous variable set. A strong prospect would be a variable characterizing the quality of hospital care. The construction of such a variable was outside the

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[12] As indicated earlier, the enacting law directs the Colorado Hospital Commission to use a cost control approach which focuses on revenue centers and revenue indicators. The departmental techniques employed in this project can be broadened to include revenue centers and revenue indicators. However, even though the Commission may sharply increase the uniformity of hospital accounting and statistical reporting, caution should still be observed in defining the revenue centers as small hospital operating units for reasons analogous to those discussed in Chapter 4 for the departmental cost variables.

scope of this project, given the extent of data bases available for the study time period. However, the scope and validity of quality-related data is steadily improving both in Colorado and across the country. Equally important, experience is being accumulated in the derivation of quality indices.[13] Therefore, a possibility which should be weighed carefully at the next comprehensive project revision is whether quality should be included as an exogenous factor.[14]

The exogenous variable set can also be altered through improvements in variable construction, i.e., substitution of a new index for a present variable. Standing out in this regard are the case mix and related indices, which could be substantially improved by requiring hospitals to report diagnoses in four-digit ICDA codes and operations in three-digit codes. Such a step would increase the validity of these indices because they could then be based on more homogeneous case cohorts. These indices could also be improved by securing case mix data for the entire hospital caseload, rather than only the Blue Cross portion of that caseload.[15] While the rationale for generalizing the Blue Cross indices to the hospital is sound, it would nonetheless put these indices on a firmer basis if they were constructed from data for the entire hospital.

Another possible future modification is to revise the composition of the two hospital groups. Such a revision could be conducted in three ways. First, the basic definition of Groups I and II could be retained, but a few hospitals could be shifted between the groups based on insights obtained during the early years of prospective payment program operation.

Second, the definition of Groups I and II could be modified. This change could be either modest or substantial. For example, the value of the average daily census, which forms the dividing line between the two groups, could be shifted from 20 to 25. As an example of a more substantial change, a case mix variable, rather than average daily census, could be used to define the two groups; or the average daily census could be retained, but with the dividing line sharply increased to perhaps 50.

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[13] For example, such indices are included in the Indiana Study.

[14] This point is reinforced by the requirement in the Colorado Hospital Commission law that hospitals must maintain a quality assurance program which monitors both utilization and quality.

[15] The initial intent of this project was to use Medicare claims data as well as Blue Cross claims data. However, after the Medicare data was obtained, it was found to be invalid for characterizing case mix because of a specific operating technique employed by the Medicare claims processing unit.

Third, the number of groups could be increased or decreased. The latter option would entail elimination of the two groups and conduct of the cost analyses and comparisons across the entire set of Colorado hospitals. Based on the results of this project, such a step appears highly inadvisable. The determinants of cost in the two groups are strikingly different. While Group I and Group II have two common final cost determinants, there are six other determinants which apply to only one group. Moreover, the effects of the two common determinants on cost are different in the two groups. Further, some variables are appropriate for one group but not for the other. The different composition of the service mix indices is a good example of this point, as is the inapplicability of the case mix, case severity, and utilization practices indices to Group II hospitals. Similarly, the departmental cost analyses are a major addition to the Group I results, while such analyses are inapplicable to Group II hospitals.

Increasing the number of groups, e.g., utilizing high, medium, and low patient census groups, is conceivably desirable in the future. However, the high predictive accuracy of the Group I and II final cost equations across their respective hospitals speaks against this possibility. The same is true for the high predictive power of the two equations. Given the number of Colorado hospitals, if the decision were made to increase the number of groups, it would be inadvisable to use more than three groups because the sample sizes would otherwise be sufficiently small to constrain the analyses.

The findings of this study are based exclusively on Colorado experience. This is a major strength because it means that the project results are tailored to Colorado hospitals. As such, they are especially adept at identifying hospitals whose cost performance is distinctly favorable or unfavorable compared to other hospitals in this state. A prospective payment program is thus likely to find these results particularly useful in modifying the cost behavior of hospitals which are positive outliers. Concentration on such hospitals should be and is likely to be a major focus of a prospective payment program during its early years. Hence, the cost comparisons are directly relevant to this important emphasis of early prospective payment program operation.

This project's focus on Colorado hospital experience also represents a weakness, since it means that the cost comparison results are not well suited, without modification, to changing the central tendency of cost performance in this state (i.e., the cost performance of the majority of Colorado hospitals). Changing the costs of hospitals which are positive outliers will reduce the inflation in total and

and average hospital costs in Colorado. However, it may have little impact on the rate of cost inflation in many Colorado hospitals.[16]

Several adaptations can make the cost comparison results more effective tools for modifying the central tendency of hospital cost performance. One is the use of inflation factors established at least partially on the basis of considerations other than actual cost experience of Colorado hospitals. For example, the prospective payment program could decide to establish a target rate of inflation (perhaps 8%) to be applied to all hospitals in a given year. As another example, the program could apply a sliding scale of inflation rates in which the permitted inflation rate varies with the hospital's adjusted dollar and percentage differences.

The simplest type of inflation factor is a single hospital-wide inflation rate, which is applied to the hospital's adjusted expected cost in order to determine the rate or comparison standard for the upcoming period. Another type of inflation factor is different inflation rates for each cost determinant, which are applied to the corresponding regression coefficients. The rationale underlying this approach is that for substantive reasons, the prospective payment program may be willing to accept higher rates of cost inflation occasioned by some determinants than by others. For example, the program may be willing to permit a 10% increase in the cost-influencing effect of medical education involvement, but only a 6% rise in the cost-influencing effect of long-term care involvement.

A third type of inflation factor is different inflation rates for each of the departmental costs, which are applied to adjusted expected costs for the base period. The logic underlying this approach is similar to that for the preceding type of inflation factor: for substantive reasons, the program is willing to accept greater increases in certain departmental costs than in others. For example, based on a variety of estimates, the program may feel that price inflation in the general economy will be lower during the upcoming time period. Consequently, the program may conclude that the acceptable level of inflation should be lower for hotel cost than for ancillary cost, since the former is more strongly influenced than the latter by general price inflation.[17]

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[16] This point applies to the direct effects of using the cost comparison results. However, the institution of a prospective payment program and the use of cost comparison results are likely to have indirect effects in terms of modifying the cost behavior of most Colorado hospitals. That is, hospital cost performance will improve to some extent simply through hospital participation in the program, independent of specific prospective rates negotiated by the program and hospitals.

[17] A similar approach could be applied to revenue indicators, if the scope of the cost comparisons were broadened in the future to include such indicators.

Another adaptation is to exclude from the cost analyses those hospitals whose relative cost performance is distinctly unfavorable (i.e., those institutions with high positive dollar and/or percentage differences). The rationale for this step is the unwillingness of a prospective payment program to have the cost comparisons influenced by hospitals which are positive outliers. If such hospitals are included, the cost comparisons are less rigorous not only for the outlier hospitals, but also for the other hospitals in the state.

A related adaptation has two key elements. The first is the identification of a sizeable subsample of hospitals (perhaps one half or two thirds of the total group) whose cost performance is relatively favorable. The second is the inclusion of only this subsample in the cost analyses, and the subsequent calculation of cost comparisons based on these analyses. The effect of this approach is to make the standard of comparison that set of hospitals whose cost performance is relatively favorable. This standard may be substantially tougher than that resulting from the analyses including all hospitals in Group I or II. This approach is thus designed to change the central tendency of Colorado hospitals, but it has the strong advantage of doing so by drawing upon the experience of Colorado hospitals, rather than by using arbitrary factors.[18]

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[18] A related use of the cost comparisons is to identify hospitals whose cost performance is highly favorable, and to then intensively study such hospitals to determine the reasons for their relative efficiencies, searching for factors generalizeable to other institutions. The departmental cost comparisons can be used for the same purpose.

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Principal Findings

The central project objective is to develop a usable mechanism for assessing the level of individual hospital costs in Colorado. This chapter summarizes the study results from the perspective of this objective. From this viewpoint the following project findings stand out.[1]

Creation of Two Hospital Groups. Because of the sizeable number of very small hospitals in Colorado, the state hospital universe was divided into two groups. Group I is composed of those hospitals with an average daily census greater than 20, and Group II is made up of those hospitals with an average daily census less than 20. This division increased the accuracy of the analyses for both groups, as illustrated by the different final cost determinants in the two hospital groups. Equally significant, some variables apply to one group, but not to the other. For example, the case mix, case severity, and utilization practices indices could not be constructed for Group II hospitals. Further, while the departmental cost analyses are inappropriate for Group II hospitals, they markedly expand the scope of the Group I results.

Strength of Group I Cost Equation. There are six final determinants of total cost in Group I hospitals. A strong rationale under-

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[1] There are other project findings which are significant in themselves. However, since they are peripheral to the overall project objective, they are not described in this chapter. For example, when the effects of other factors are taken into account, specialized service mix has an insignificant influence on Group I hospital costs, and surgical concentration has an insignificant impact on Group II hospital costs. However, the specific identity of the cost determinants is not directly relevant to the overall project objective as long as there is a solid substantive rationale accounting for the impact of each determinant on cost.

The same logic holds for results concerning an individual hospital. To Hospital (22), CBC, the newly created Colorado Hospital Commission, and others in Colorado, it is of interest that the former's dollar difference is -$18 (in the actual/expected comparison) and that the members of its peer group are Hospitals (02), (10), (15), (24), (34), and (45). However, these specific results by themselves are secondary to the main project objective, although illustrative of the attainment of that objective.

lies the influence of each determinant on cost. Similarly, sound reasons account for the insignificant effects of the other exogenous factors on cost. The six determinants alone are responsible for approximately 90% of the variation in total cost among Group I hospitals. The impact of each determinant is both statistically significant and substantial in dollar terms. The predictive accuracy of the equation is similar for different subsamples of Group I hospitals, and thus the equation is applicable across the entire set of Group I institutions.

The substantive and statistical properties of the final cost equation are thus strong. As a consequence, this equation forms a firm basis for the Group I cost comparisons.

Distinctiveness of Departmental Costs. Five mutually exclusive departmental costs were created -- nursing cost, ancillary cost, hotel cost, administrative cost, and capital cost -- each of which focuses on a different facet of hospital operations. In accord with the substantive framework, the five departmental costs are influenced to varying degrees by exogenous factors. For example, surgical concentration has a strong impact on nursing and ancillary costs; a weaker, but still significant, influence on hotel and administrative costs; and an insignificant effect on capital costs.

Hence, the five departmental costs are substantively and statistically separable. As a result, important insights about hospital cost structures can be gained by analyzing the departmental costs.

Consistency of Departmental and Total Cost Analyses. While the statistical properties of the departmental cost equations are not as powerful as those of the total cost equation, they are sufficiently strong to form a sound foundation for the departmental cost comparisons. Equally important, the findings of the total and departmental cost analyses are mutually supportive. This result strengthens the substantive framework of the entire cost analyses, since the rationale for the impact of the determinants on total cost is based on their expected effects on the departmental costs. These expected effects are present in the departmental cost analyses. For example, the effects of bed size on nursing, hotel, and administrative costs are greater than its influence on total cost, while the impact of bed size on ancillary and capital costs is insignificant.

Soundness of Group II Cost Equation. There are four final determinants of total cost in Group II hospitals. A solid rationale accounts for the influence of each determinant on cost. These determinants are responsible for 80% of the variation in Group II hospital costs. The influence of each determinant on cost is statistically significant and sizeable in dollar terms. The predictive accuracy of the equation is similar across Group II hospitals.

Therefore, like the Group I equation, the characteristics of the Group II equation are strong and it represents a solid basis for the Group II cost comparisons.

Identification of Hospitals Which are Cost Outliers. Two cost comparison techniques are employed in this project. One entails the direct comparison of a hospital's actual cost with its expected cost, i.e., the cost level expected given the hospital's values for the cost determinants. In this actual/expected comparison, the majority of Group I hospitals have a cost performance similar to that expected. In particular, almost 60% of these institutions have actual costs within 10% of their expected costs. However, the comparison also identifies a significant number of hospitals which are sharp positive and negative outliers. Three Group I hospitals have actual costs at least $300 higher than their expected costs. Another three Group I institutions exhibit actual costs more than $150 lower than their expected costs. Similarly, five Group I hospitals have actual costs more than 20% higher than their expected costs, and three Group I institutions have actual costs more than 20% lower than their expected costs.

Advantages of Unique Peer Group Approach. The other cost comparison technique is the actual/peer group method, which has two steps. The first is the development of a peer group for each hospital, and the second is the comparison of each hospital's actual cost with the average actual cost of its peer group members.

The construction of peer groups is premised upon two key principles. The first is that each hospital should have a unique peer group. This approach ensures that each hospital is near the center of its peer group and is not arbitrarily stuffed into a fixed peer group. The second principle is that the parameters used to group hospitals should not be arbitrarily selected, but rather should be those factors which strongly influence hospital cost in Colorado, i.e., the final cost determinants.

Implementation of this approach for Group I hospitals yielded only one mutually exclusive peer group and no identical peer groups. These findings solidly support the efficacy of the unique peer group approach. There are four Group I hospitals for which a satisfactory peer group cannot be constructed -- a finding which represents a weakness of the actual/peer group technique as opposed to the actual/expected technique. It does not, however, signify a weakness of the unique peer group approach, since the fixed peer group technique would have been no more satisfactory for these hospitals. In fact, it might have been less satisfactory since fixed peer groups might have been inappropriately assigned to these institutions.

Integrated Usage of Cost Comparison Techniques. For Group I, the convergence between the findings of the actual/expected and actual/peer group techniques is much greater than the divergence between these results. However, the latter is sufficiently high that the results of the two techniques can differ appreciably for individual hospitals. Specifically, for at least 20% of Group I hospitals the divergence is sufficient to alter the conclusions drawn from the cost comparison findings.

Given the lack of precise convergence between the findings of the two techniques, it is important to consider their strengths and weaknesses. The major comparative advantage of the actual/expected technique is that its results are more accurate for any given time period. The main comparative strength of the actual/peer group technique is that its findings can be continually updated as long as the peer group remains stable, i.e., appropriate for the primary hospital. This can be done by periodically obtaining the actual costs of the primary hospital and its peer group members.

Therefore, the best use of the two techniques is to utilize the actual/expected method to determine the expected cost of each hospital for each base period, and to employ the actual/peer group method to obtain inflation rates in order to update those expected costs between base periods. This integrated utilization of the two techniques is superior to the usage of either technique alone.

Importance of Departmental Cost Comparisons. In this project, departmental cost comparisons are derived by applying the actual/expected technique. There is a very strong convergence between these findings and the actual/expected total cost comparison results. The correlation between the total dollar difference (i.e., actual cost minus expected cost) and the sum of the departmental dollar differences exceeds .99. For only six Group I hospitals is the divergence between these two statistics greater than $10. This strong convergence both facilitates the joint usage of the departmental and total cost comparisons, and further supports the validity of the Group I cost analyses.

The purpose of the departmental cost comparisons is to flesh out the total cost comparisons. That is, if a hospital's actual cost exceeds its expected cost, which departmental costs are primarily responsible for the overage? The same paradigm applies if a hospital's total dollar difference is negative. The departmental comparisons thus target those departmental areas which should be reviewed most heavily by the prospective payment program and the hospital.

The departmental profiles (i.e., the departmental comparison results) of individual hospitals vary substantially. This finding is illustrated by the departmental profiles of those hospitals whose actual costs differ markedly from their expected costs. Further, each depart-

mental dollar difference has a significant impact on the total dollar difference. Therefore, although one or more departmental dollar difference(s) may approach zero for an individual hospital, a prospective payment program cannot afford to systematically neglect any departmental dollar difference across a number of hospitals.

Similarity of Group II and Group I Cost Comparisons. The findings of the Group II comparisons resemble those of the Group I comparisons. In the actual/expected comparison, almost 60% of Group II institutions exhibit actual costs within 10% of their expected costs. There are also hospitals whose actual costs vary substantially from their expected costs. In fact, a Group II hospital has the largest dollar difference among all study hospitals. Its actual cost exceeds its expected cost by $536. However, those Group I hospitals with high positive dollar differences have a greater impact on state hospital costs because they are larger institutions.

There are no identical or mutually exclusive peer groups for Group II institutions, a finding which indicates the superiority of the unique peer group approach for Group II hospitals. As in Group I, satisfactory peer groups cannot be developed for four Group II institutions.

The convergence between the findings of the actual/expected and actual/peer group techniques is higher for Group II hospitals than for Group I institutions. Even so, as in Group I, the divergence between the findings of the two techniques is sufficient to modify the implications of the cost comparison results for at least 20% of Group II hospitals.

Major Functions of Cost Comparison Results. The cost comparison findings can be employed for two general purposes by a prospective payment program. First, they can be used in the rate-setting process. In this role they can be utilized in several different ways. The comparison findings can be converted directly into rates; they can be employed in conjunction with different types of sliding scales to establish rates; or they can be used as a general guide for rate determination. However, regardless of their specific application, if they are used in the rate-setting process, they should be adjusted to take into account unique hospital characteristics.[2]

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[2] A justifiable exception to this principle arises in the case of Group II hospitals and possibly Group I institutions, whose actual costs differ only modestly from their expected costs. It may be prudent for the prospective payment program to accept without adjustment the expected costs of these hospitals and to correspondingly pay these institutions their actual costs.

The second purpose for which the comparison results can be used is as a criterion to determine the depth of individual hospital budget review. That is, the greater the positive deviation between a hospital's actual cost and its expected cost, the more extensive, in general, should be its discussions with the prospective payment program. For this objective the cost comparisons can be used directly in their unadjusted form, since their purpose in this instance is to signal the extent of budget review that is probably required. As part of that review, unique hospital characteristics can be considered and appropriate adjustments made in the comparison results.

Strength of Cost Comparison Results. As a whole, the preceding findings indicate that this project succeeded in attaining its primary objective. It produced cost comparison results which represent a valid and workable mechanism for evaluating the level of individual hospital costs. The strength of the cost comparison results is that they are directly based on those factors which broadly influence hospital costs in Colorado.

The comparison findings can be effective in reducing hospital cost inflation because they provide the overall perspective crucial to the meaningful assessment of hospital costs by a prospective payment program (or by any program evaluating hospital costs). Equally important, the comparison findings are equitable to individual hospitals since they recognize justifiable cost differences among hospitals.

Generalizability of Project Methodology. From a methodologic perspective the unique feature of this project is not any single technique. Instead, it is the systematic application of a set of techniques for a practical purpose. That is, this project utilizes an array of analytical techniques, many of which have been sharpened in recent years, and blends with those techniques specific knowledge about Colorado hospitals and practical considerations about prospective payment programs.

Colorado as a state and Colorado hospitals as institutions have distinctive characteristics, and their features are not extreme compared to the rest of the United States. Therefore, given the effective application of the study methodology in Colorado, it is probable that it could be used successfully in most other states. The specific findings would naturally vary among different settings. For example, it would be unlikely that the cost determinants in another state would be precisely the same as those in Colorado. Similarly, the particular analytical techniques employed should be modified to fit the setting. As an example, in another state it might be appropriate to treat the state hospital universe as a single group, or it might be advisable to segregate that universe into three, rather than two, groups.

However, the main features of the project methodology -- the two-step cost assessment approach, the solid substantive framework, the application of regression analysis, the inclusion of departmental costs, and the utilization of two cost comparison techniques -- appear applicable to most other settings.

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